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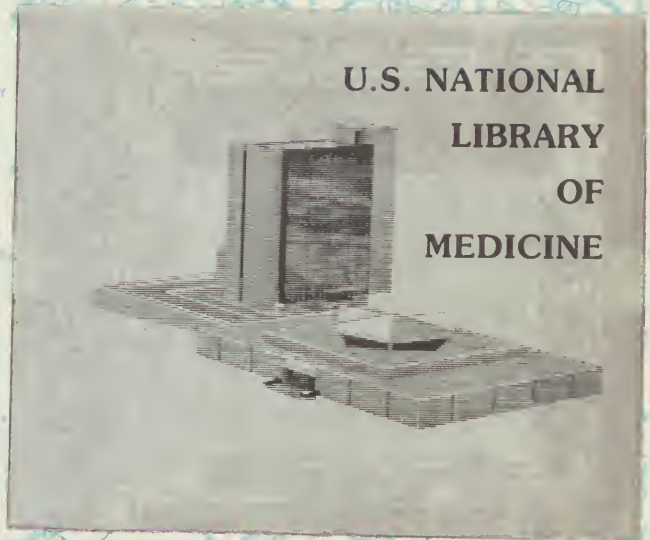

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HEARINGS ON SCIENCE LEGISLATION

(S. 1297 and Related Bills)

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON MILITARY AFFAIRS UNITED STATES SENATE

SEVENTY-NINTH CONGRESS

FIRST SESSION

PURSUANT TO

S. Res. 107

(78th Congress)

AND

S. Res. 146

(79th Congress)

AUTHORIZING A STUDY OF THE POSSIBILITIES OF BETTER MOBILIZING THE NATIONAL RESOURCES OF THE UNITED STATES

PART 3

OCTOBER 22, 23, 24, 25, and 26, 1945

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CONTENTS

ALPHABETICAL LIST OF WITNESSES

HEARINGS ON SCIENCE LEGISLATION

S. 1297 and Related Bills

MONDAY, OCTOBER 22, 1945

UNITED STATES SENATE,
COMMITTEE ON MILITARY AFFAIRS,
SUBCOMMITTEE ON WAR MOBILIZATION,
Washington, D. C.

The subcommittees met at 10:05 a. m., pursuant to adjournment on October 19, 1945, in room 457, Senate Office Building, Senator Guy Cordon, Oregon, presiding.

Present: Senator Guy Cordon, Oregon, and Senator C. Wayland Brooks, Illinois.

Also present: Dr. Herbert Schimmel, chief investigator; Mr. John H. Teeter, director of hearings for Senator Magnuson.

Senator CORDON. The hearing will please come to order. We seem to be a little short on committee attendance this morning due to the fact that many members of the committee have been unavoidably detained on other important business, either in Washington, or outside the city.

The first witness this morning, Dr. A. N. Richards, is Chairman of the Committee on Medical Research of the Office of Scientific Research and Development. Dr. Richards, we will be glad to hear from you.

TESTIMONY OF DR. A. N. RICHARDS, CHAIRMAN OF THE COMMITTEE ON MEDICAL RESEARCH OF THE OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT

Dr. RICHARDS. Mr. Chairman, I have been the Chairman of the Committee on Medical Research since its establishment as a division of the Office of Scientific Research and Development in July 1941. During the same period I have continued to serve the University of Pennsylvania as its vice president in charge of medical affairs.

On the assumption that my statement has been requested because of my knowledge of the activities of the Committee on Medical Research and because the record of the work of that committee may be useful to those who are responsible for the design of legislation, I shall begin with a brief account of the organization of the Committee and its methods of functioning.

The Committee consists of seven members: Four civilians who were appointed by President Roosevelt; a representative of the Army Medical Corps appointed by the Secretary of War; a representative of the Bureau of Medicine and Surgery appointed by the Secretary of the Navy; and a representative of the United States Public Health Service appointed by the Federal Security Administrator. One of the civilian appointees was and still is Chairman of

the Division of Medical Sciences of the National Research Council, a quasi-governmental organization, established in 1916 by the National Academy of Sciences, and perpetuated by Executive order of President Wilson in 1918—an organization which shares with the National Academy of Sciences the duty of giving advice on scientific matters to Government agencies when requested.

The CMR was, as has been stated, appointed in July 1941. Its instructions were to assist the Director of the OSRD in his task of mobilizing the scientific and medical personnel of the Nation in the interest of the national defense. But for 15 months previously, the Division of Medical Sciences of the National Research Council had periodically been presented by the Surgeons General of Army and Navy with questions relating to military medicine on which expert civilian medical advice was desired. To answer these questions, the Chairman of that Division appointed committees of experts who came to Washington, sat with representatives of the Services and formulated such replies as could then be made.

Those discussions revealed gaps in knowledge which could only be filled by research. Funds in adequate amount with which to finance research were not available. Hence, a situation had developed in which problems, recognized as important for the national defense, were urgently demanding research for their solution; groups of competent advisers were informed of those problems; but no governmental agency existed with power to authorize and finance the necessary investigations. It was to meet those necessities that the CMR was created as a division of the OSRD under the directorship of Dr. Bush. The number and variety of problems awaiting and prepared for study can be inferred from the fact that at the time of the creation of CMR there had been set up in the Military Medicine section of the medical division of the Research Council 7 main committees and 32 subcommittees with a membership of 354 persons.

With these considerations in mind, the CMR at its first meeting on July 31, 1941, made four important decisions; Dr. Weed, Chairman of the Division of Medical Sciences of the National Research Council and an appointee of President Roosevelt, was elected vice chairman of the CMR; the chairmen of the main committees of his division were appointed consultants to the CMR; an understanding was reached that the Research Council committees and subcommittees were to act in an advisory capacity to the CMR; and a contract with the National Academy of Sciences was recommended to the Director of the OSRD which would reimburse the Council for the expenses of committee meetings, of the conferences of CMR investigators and of the preparation of reports.

Without the help of those organized committees of the National Research Council or of an equivalent organization of advisers which the CMR would have been obliged to set up had the Research Council committees not existed, the responsibilities of the CMR could not have been discharged.

Since its establishment 4½ years ago, the CMR has held 120 meetings. During that time the advisory Research Council committees have held a total of 665 meetings and 228 conferences of investigators. These committee meetings were regularly attended and participated in by liaison officers of the interested divisions of the services. Through those liaisons and through the service members

of the CMR collaboration with the Surgeons General, and through them with medical officers in the field, has been effected.

The work of CMR has largely been done by contracts with universities, medical schools, hospitals, and research institutes; in a few important instances by transfer of funds to other Government agencies; in a few instances also by contract with the research organizations of industrial firms.

Five hundred and eighty-two such contracts have been approved by the Director of the OSRD on recommendation by CMR. The list shows 452 with universities, 48 with hospitals, 38 with research institutes, 22 with other Government agencies, and 22 with commercial firms. Expenditures during the 4 years have amounted to approximately $24,000,000.

The number of investigators involved has been 5,431, of which number 644 are physicians, 1,038 hold high degrees other than that of M. D., and 3,749 are of lesser grades of academic rank.

The geographical distribution of contracts is as follows: North Atlantic States 317; South Atlantic, 24; North Central, 131; South Central, 42; Rocky Mountain, 6; Pacific Coast, 59; Canal Zone, 3. This distribution agrees roughly with the distribution of medical schools in this country. Decisions concerning the placing of contracts have been made wholly upon considerations of the human and physical resources and their adaptability to the problems whose solution was necessary. By human resources, I mean men with scientific learning, skill, and experience in the experimental method which gave reasonable promise that useful results could be expected from their efforts.

Now follows a summary list, necessarily incomplete, of subjects in the medical field which have been studied by investigators working under contract with the OSRD recommended by the CMR. Advances have been made in all of these subjects, and, in some, the advance has been significant beyond expectation.

With your permission, Mr. Chairman, may I omit, but ask to have included in the record, the list which follows?

By divisions; in the medical field, 10 general subjects; in the field of infectious diseases, 10 general subjects; tropical diseases, 8; nutrition, 8; psychiatry, 4.

Division of surgery, 12.

Division of aviation medicine, 7.

Division of physiology, 11.

Division of chemistry, 4.

Malaria, three broad divisions, each very comprehensive.

(The list is as follows:)

Division of medicine

Infectious diseases.—Gas gangrene, dysentery, influenza, atypical pneumonia, paratyphoid and paracolon infections, venereal diseases, prophylaxis and treatment of hemolytic streptococcus infections, minimal tuberculosis in the Army, septicemia and bacterial endocarditis, air disinfection and control of airborne infections.

Tropical diseases.—Malaria, cholera, plague, schistosomiasis, filariasis, leishmaniasis, amebic dysentery, fungus diseases of the skin.

Nutrition.—Metabolism in disease and convalescence, anemia following burns and infections, diet in relation to convalescence.

Psychiatry.—Methods of assay of neurotic potentialities, analysis of psychiatric casualties, social and psychological rehabilitation of the physically handicapped, psychological aspects of convalescence.

Division of surgery

Control of anerobic wound infections; laboratory, clinical, and statistical studies of infected wounds and burns, with particular reference to the usefulness of sulfa drugs and penicillin; healing of wounds and burns and its possible acceleration; new suture materials; shock and toxemia following burns; nerve regeneration and nerve repair following nerve injury; techniques of diagnosis of nerve injury and regeneration; reaction of the spinal cord to injury, cerebral concussion; evaluation of neuropsychological factors in effects of head injuries. Prosthetic devices; wound ballistics.

Division of Aviation Medicine

Physiological aspects of anoxia, decompression sickness (bends), and low temperature. Means for increasing the aviator's ceiling. Devices to prevent "black-out." Analysis of crash injuries and design of means to prevent them. Visual mechanisms in relation to flying and development of instruments to improve visual efficiency. Oxygen supply systems, theory and practice. Motion sickness. Methods for improving selection and training of aircraft personnel.

Division of Physiology

Nature, prevention, and treatment of shock.—Blood plasma proteins, their separation, purification, and therapeutic utility; methods of preserving blood and red blood cells for transfusions; blood substitutes for transfusions. Physiological adaptations to heat, cold, and humidity; development of clothing fabrics suited to extremes of climate; diet and fatigue; disinfection of water; effects of dehydration and cooking upon quality and nutritive value of foods; water and salt requirements of shipwrecked men and men in the desert; shark repellents.

Division of Chemistry

Treatment and hospital studies of gas casualties.—Pharmacology of new toxic agents, prevention and treatment of injury to skin, eyes, and lungs. Decontamination of foods; psysiology of the skin.

Insect and rodent control.—Mode of action of insecticides and insect repellents and methods of use, new insecticides and rodenticides.

Division of Malaria

New potential antimalarials; their chemical synthesis, tests of their effectiveness in avian and simian malaria, their pharmacology and toxicology, their effect on induced malaria infections in man. (More than 13,000 compounds have been studied. Atabrine: assay of American product, methods of determination in body fluids, dosage regime, and specifications of atabrine discipline. Biology of malaria parasites. Immunization against malaria.)

Penicillin

Chemical constitution and efforts to synthesize it or its therapeutic equivalent. (This is in addition to extensive studies of its therapeutic importance.)

Dr. Richards. From the above list, I wish to choose four examples illustrative of one of the considerations which I think should be strongly emphasized: Namely, that the type of research which the CMR has sponsored is developmental rather than what is called fundamental or basic. They form a preface to the argument that, in the medical field, the function of a National Research Foundation should differ in important respects from that of the CMR.

1. *Penicillin.*—The existence of this substance was discovered and its therapeutic potentialities predicted by Fleming of London in 1929. The beginnings of its purification and of the demonstration of its therapeutic utility were made by Florey and his group in Oxford in 1939, '40, and early '41. But England, during her war years, could not spare the facilities and manpower with which to proceed with the further development of penicillin. America had both, and in the

autumn of 1941, under the stimulus of Florey's representations, our organized effort got under way. Its ultimate success was due to the following initial factors: A confident belief held by members of the CMR and shared by the Director of OSRD in the validity and promise of the British work; the able collaboration of mycologists and chemists of the United States Department of Agriculture; the willingness of certain American pharmaceutical manufacturers to undertake production research at large expenditures of money and effort; the enthusiastic, intensive clinical study by physican investigators of the therapeutic capacities and limitations of the new substance; and finally, the later effort by the War Production Board, which resulted in the enlistment of enough commercial firms to supply the wartime national need for the drug. This combination was the basis of our success in supplying in quantity to our armed forces and to those of our British Allies before D-day a new drug, more potent against a greater variety of microorganisms than any previously known. Incidentally, a great new industry of enormous peacetime significance has been created.

It is incontestably true that without the prewar work of Fleming this accomplishment would not have been produced. It seems equally true that without the resources which our war effort made available, the extraordinary job of developmental work in the United States would not have been done. Furthermore, inasmuch as Fleming's great discovery resulted from an accidental contamination of his cultures, the study of which was a digression from the main course of his research, it is highly questionable whether the discovery would have been made had he been working under restrictions such as Government contracts in wartime have imposed.

The investigative work which has already given the physician invaluable information as to what he can accomplish with the aid of penicillin in the treatment of disease or injury is clearly developmental or applied and not basic research; and while its value cannot be overestimated, its nature as an intellectual effort must not be misunderstood.

Senator CORDON. Just a moment, please. With reference to the experimental work done on penicillin, was any of that done under the direction of your committee?

Dr. RICHARDS. Yes. It was. Florey came to this country in July of 1941. He brought with him the manuscript of an article which was to be published in the August issue of the Lancet for that year, which outlined the success he had had in a few cases of infections, partial success, I should say, and which needed amplification.

Dr. Bush called a meeting in his office in October of that year, at which scientific representatives of four industrial firms were present, also the chief mycologist of the Department of Agriculture, the Chairman of the Division of Chemistry of the National Research Council, the Chairman of CMR and Dr. Bush himself, in order to find out whether a joint effort might not be initiated which would give us more information as to the possibility of producing that drug here.

It was all a gamble. The representative of one particular firm was enthusiastic about cooperation. The others didn't know too much about it and were cautious.

Another conference was held in December of the same year, at which the heads of companies were present, and it was agreed that information would be shared through the intermediation of the Committee on Medical Research, and all four companies agreeing to put

their research teams or fractions of them on the problem. As a result, we began to get a trickle of a supply of penicillin during the early months of 1942. It was given to us for distribution without charge to the Government and was passed on to physician investigators chosen by the Committee on Chemotherapeutic Agents of the National Research Council. That arrangement continued all through 1942 and up to February 1 of 1943, when the Committee decided that they ought not to allow those firms to put so much money, without any reimbursement, into the project.

One firm, for example, had given penicillin in an amount which in dollars represented over $80,000, without any return.

We discussed the cost with the companies and came to the conclusion that $200 a million units would be a fair recompense, and from then on we bought the supplies of penicillin, which were passed over to these physician investigators for clinical study.

Senator CORDON. I was seeking chiefly to know whether any of your contracts mentioned, with medical schools, and so forth, had embraced anything in connection with the study of penicillin.

Dr. RICHARDS. We supplied penicillin to these physician investigators first in 9 places and later something like 30 or 40. We had a general over-all contract with the Massachusetts Memorial Hospital, because of the fact that the chairman of the National Research Council on Chemotherapy was an officer of the Evans Memorial Hospital, which is a unit in that organization. He was empowered by contract to buy penicillin and distribute it in the judgment of that committee, subject, of course, to the reviewing power of our committee.

We didn't have contracts with the commercial firms. They preferred not to work under contract and we got all the advantages of a contract without cost to the Government.

Senator CORDON. As I understand you, then, the investigation which led to the production of penicillin and its almost universal use, was voluntary and gratuitous to a very great extent, and your committee's chief job was that of integrating the efforts and sending the information gained to those interested.

Dr. RICHARDS. The production research by commercial firms was done at their own expense; OSRD, on recommendation by our committee, helped finance the work of the Peoria laboratory of the Department of Agriculture and, after February 1, 1943, bought all of the penicillin supplied to the clinical investigators.

If you would permit me to add one further item; somewhat later it was discovered that penicillin was remarkably effective against venereal disease and when that discovery had been confirmed a program of investigative work was undertaken under our sponsorship, but under the direct management of the Committee on Venereal Diseases of the National Research Council, and then started a big and expensive program of contracts with university investigators, to discover just what the limitations were of penicillin in the treatment particularly of syphilis, how it should best be used, and what the later sequels of its action would be. That investigation is going on intensively at the present time.

Senator CORDON. One other question, Doctor, if I may. Was your committee formed by Executive order?

Dr. RICHARDS. Yes, sir; Executive order of June 27, 1941, the order which created the Office of Scientific Research and Development.

Senator CORDON. The funds which were allocated to you were expended upon whose order?

Dr. RICHARDS. They were obtained by direct appropriation from Congress; from year to year Dr. Bush and the chairmen of the committees under Dr. Bush appeared before the House Appropriations Committee and defended their requests.

Shall I proceed?

Senator CORDON. If you will.

Dr. RICHARDS. 2. *DDT.*—This insecticide, about which everyone now knows, was made as the outcome of chemical curiosity in a German laboratory 71 years ago. Its insecticidal power was demonstrated in Swiss potato fields five or more years ago. A little of it was sent to this country in 1942, along with the information that it possessed an extraordinary power to kill flies. After our chemists had learned to synthesize it and our manufacturers to make it, its capacities and methods of using it were subjected to energetic study by the Bureau of Entomology and Plant Quarantine of the Department of Agriculture, with funds transferred to it by the OSRD on the recommendation of CMR; also by the research organizations of the Surgeon General's Office and the Office of the Quartermaster General, by the Air Force and the Public Health Service with results now widely known. With its aid the typhus epidemic in Naples was aborted and our power to control malaria in tropical regions by sanitation has been vastly increased.

The point I wish to make is that our wartime research on DDT and other insecticides and repellents is applied research, pure and simple, and in no sense basic or fundamental.

3. *Blood plasma proteins.*—During the period between the two world wars, the efforts of academic and industrial scientists had succeeded in inventing and perfecting methods for drying human blood plasma under conditions which prevented chemical alteration of its labile, protein constituents. They had learned, too, of the usefulness of blood plasma, when given by injection into a vein, in restoring the heart and circulation of a wounded man who might be in extremis from shock and loss of blood. Hence the Medical Corps of our armed forces were equipped at the beginning of our participation in the war with a new and important means of saving lives of wounded men.

The containers in which dried blood plasma is prepared and transported are bulky. For that reason the Navy raised the question whether the efficacious constituents of plasma could not be supplied in more concentrated form in order that shipping space might be economized. The question was referred to a chemist who had spent years of effort in attempting to increase his knowledge of the nature and characteristics of proteins—among them, proteins of the blood. He quickly succeeded in devising methods for producing a solution of the albumin of blood plasma, five times more concentrated than it is in plasma and stable within a wide range of temperatures. This solution proved to be as effective in the treatment of shock and hemorrhage as plasma itself. Going further along a course directed by the belief that each of the constituents of our blood serves some purpose useful to the body, he devised methods for separating in pure form the constituents of blood which cause it to clot with the result that surgeons can now be supplied with sponges made of pure blood constituents which, applied to bleeding surfaces, cause prompt stopping of the hemorrhage.

Going still further along the same course, he and his group in collaboration with two other groups, succeeded in separating from the blood, in the form of a dry white powder, the proteins in which reside the

property of blood which protects us from certain infections. Large-scale tests, first on civilian groups, later on Army groups in the field, have shown that this preparation acts as a preventive and also as an ameliorating agent in two virus diseases, measles and infectious jaundice.

In the work of these investigators we find a brilliant example of contrast between "fundamental" and "applied" research. An inquiry into the constitution and physico-chemical characteristics of protein molecules, conducted for the sole purpose of increasing knowledge and understanding, proves, when amplified by study of practical applications, to provide the basis of a supply of new and life-saving substances.

4. *Malaria.*—The degree to which we have succeeded in overcoming the menace of malaria to our overseas forces is the outcome of prewar, peacetime discoveries: The mosquito transmission of the parasite, antimalarial sanitation, atabrine, and DDT. Organized energetic effort, atabrine discipline, and adequate financing, rather than fundamental science, are the means by which we have been enabled to outwit the mosquito in the tropics. The OSRD has spent and is still spending large sums in an organized search for a new antimalarial drug which, in harmless dosage, shall render man immune to the bite of an infected mosquito. A hundred chemists are making new compounds; biologists and pharmacologists are testing their capacities not only to prevent or control experimental malaria in animals but also to do harm to the human body; and groups of hospital investigators are producing malaria in human volunteers in order to test such drugs as survive the screening tests on animals as to their effectiveness in preventing or curing the naturally acquired infection in man. This effort was undertaken both because of insistent requests from the armed services, and also because of the conviction that somewhere in nature or in the inventive mind of man there exists, actually or potentially, a true prophylactic against malaria.

Thus far, that objective has not been reached. The best that can be said is that new or hitherto unused drugs are in prospect which were either known before the war or are developments of those, and which, while superior in some important respects to atabrine or quinine, are qualitatively similar in their therapeutic power. That is, they suppress but do not prevent or cure. I cite this as an example of the difficulty of making discoveries to order.

Were I to go through the entire list of CMR investigative projects, I am sure that I could show that in the great majority of cases such results as have emerged which are of practical importance had their origin in prewar, academic work, undertaken with little or no aim at practical usefulness. The four examples cited were deliberately chosen because their results have been exceedingly important in the war effort—in two cases at least, spectacularly so. They are so widely known among the lay public that they may well give rise to a general belief that with the dissolution of the OSRD a new CMR should be created in order to continue in the postwar period research of the same type and general purpose as that which has proved to be so rewarding during the war. If such a belief should be a controlling factor in the design of the legislation which shall be the outcome of these hearings and the deliberations in the Congress which are to follow, a disastrous result will have been achieved.

The phrase has been and should continue to be often repeated, that during the war we have been spending our scientific capital. If we do not wish to go scientifically bankrupt, we must see to it that our investigators return to their more deliberate habit; that they cease to be bedeviled by such requirements as that of bimonthly reports to an authority in Washington; that they shall be permitted, encouraged, and helped to follow the dictates of their scientific consciences; and, above all, that they be encouraged to help young men to develop the inquiring mind and experience in the experimental method.

The man who, more than anyone else, was responsible for developments in the blood-plasma work to which I have referred was asked whether he would wish to continue work under sponsorship of a National Research Foundation, should Congress decide to create it. He replied that he would feel honored to receive its support insofar as it might make possible more intense scientific development of untrammeled long-range research, particularly at the creative and imaginative level. He would place more emphasis on acquiring the fundamental knowledge which must now be gained in the natural sciences if we are to make more, far-reaching contributions to medicine and the public health.

Another colleague in medical science, Dr. H. S. Gasser, director of the Rockefeller Institute, himself a distinguished physiologist and a recent recipient of the Nobel prize, has written me his views concerning the subject we are discussing.

They are so thoroughly representative of those held by the many other scientists with whom I have consulted and they express my own views so much better than I could that I have asked his permission to include in this statement a rather long quotation from his letter. I should like your permission, Senator, to read it.

Senator CORDON. If you will.

Dr. RICHARDS (reading):

> There is only one question to ask with respect to Government support of research, and that is how it can be given most effectively.
>
> At the outset, in the interest of clarity, I must introduce some remarks about two catchwords often used with respect to research: "applied" and "fundamental." To me the words do not designate two mutually exclusive forms of research, nor do they connote anything about the relative merits of the forms as far as they can be separated. But they do clearly stand for two ways of looking at research. Whether one selects one viewpoint or the other makes a big difference with respect to the course of action one would want to follow.
>
> When one is embarking on applied research the path is already broken. There is spread out before one a vista of many things waiting to be done. A deliberative body can think of organization to exploit them at a greater or lesser tempo according to their judgment. On the other hand, when one is thinking about the future of fundamental investigation, one is before a wall the details of which are so unresolved that it appears blank. No one sees the way through. No one knows what lies beyond. There is nothing one can do about it except to make conditions favorable for individual investigators fired with the desire to extend the frontier of knowledge, in the hope that some of them, through their insight, industry, and good fortune will reveal the ways into the unknown.
>
> So much is currently said and written about the merit of having now all the advantages of what science has already opened up, that further comment is superfluous. This end can be expedited by organization, as the experience during the war has shown; and out of the activity that this type of organization can implement it is also possible that unexpected developments of fundamental importance may arise. But if that is all that is to be done in behalf of fundamental investigation I must vigorously protest, if for no other reason, because of the limitation of the sectors of the frontier that would be brought under survey. It is a time for earnest pleading of the case of the individual investigator. I am pleading. It is a

time to quit laughing at the scientist in his ivory tower and to realize that he may be the most practical man among us. I am also pleading for that.

Science is the product of the work of scientists. This is a point that can be all too easily missed by legislators. The conditions under which scientists work are important, and the most important condition is freedom. An investigator is not at his best when he is harassed by unnecessary reports, when he has to get the permission of someone to change his direction, when he thinks that his accomplishment must come within the compass of a stated time, when he lacks the necessary equipment and supplies, or when he himself must perform time-consuming technical procedures that could be done for him. This sentence gives hint both of what to do and what not to do. In summary, it says that the scientist must be supplied with the right environment. If it does not tell how the environment is to be supplied through Government support, it at least sets forth necessary conditions that must be faced. And any plan for aiding research that does not face them is not only doomed itself to fail, but is potentially retrograde in that a large national appropriation creating competition for talent would decrease the effectiveness of what is now being done with private and State funds.

Decisions about where and to what extent to foster the necessary environment call for the nicest kind of judgment. And all that one can expect from an interested body is that in the end their good bets outnumbered their poor bets. My best thought is that funds be given with as few strings on them as possible to institutions with a research tradition, and to leave the details of allotment to the institutions' internal administration. In pursuit of this policy I would lay emphasis on consideration of geographical distribution and on the seeking out of small institutions where the investigative spirit is frustrated by the absence of margin in the budget for purposes beyond the demands of teaching.

For it is my firm conviction that the measure of the scientific strength of the country as a whole will become large in proportion to the breadth of the structure upon which it rests.

The thoughts which I have been trying to develop can be brought to a focus in some such fashion as this: The country needs a great increase in the number of its scientists, fitted by quality and bent of mind to extend the frontiers of our knowledge of nature and nature's laws. This increase can be effected by discriminating selection of young men of demonstrated talent and by seeing to it that their training, both in quality and duration is designed to guarantee, insofar as that is possible, their later, mature competence. This selection and this training cannot be accomplished unless we give heed to the present generation of effectively productive scientists, and see to it that the conditions under which they are working are optimal, not only to maintain their individual productiveness but also to provide them with worthy disciples and with material facilities. They must be trusted to select their own tasks and must be made to feel that government has no other intention with respect to them and their work than to encourage and foster. If a National Research Foundation can effect these two aims, we can be assured of the restoration and increase of our "scientific capital," and also that from it will flow a remuneration to the Nation comparable to that which science has paid in during the period of the war. The unit toward which the contemplated legislation must be directed is the human individual whose mind has a peculiar bent toward science—knowledge. Its aim must be first to seek him out; then to help and comfort him in what at times is a thrilling, but more often is a disheartening task of finding out for himself what nobody else yet knows.

The desire of the country for a continuation of flow of results of applied or developmental research has been made clearly apparent since the publication of the Bush report. The satisfaction of this need, in part at least, may well be included within the objectives of a National Research Foundation. Insofar as this type of research shall

be conducted in universities and other private institutions, a certain kind and degree of organization may be helpful—even necessary. Such organization however should not have the rigidity and power of control which seemed necessary to effect the military objectives of science in wartime. It should be the sort of organization which in a sense organizes itself on the basis of community of interests and mutual respect. The Foundation should make it possible that the necessary conferences and free discussions among investigators who have a common interest shall never be prevented by lack of money. Improvement in air travel should obviate distance as a deterrent to such meetings and should promote the scientific unity of our entire country.

I wish to reiterate the expression of my conviction, which I believe to be shared by every investigator deserving of the title, that we must not think that organization can accomplish that which can only be accomplished by the inspiration or intuition of the mind of a scientist. Organization might be helpful; I suspect it would be more apt to hinder. The conception that a 2-billion dollar Manhattan District project aimed at the cure and prevention of cancer will have early success seems to me to be fallacious. In that field no such pathway to the goal is now apparent as that which, in the field of atomic energy, was opened by the discovery made by Hahn and Strassmann in 1939.

One can assume that organization of effort against cancer would consist of a listing of all the fields and subdivisions of fields of plant, animal, and human biology in which the listers think that old paths can be extended or new paths opened up which will lead to the goal; a listing of the plant, animal, and human biologists whose interests are already in or can be directed into those fields or subdivisions. Then would come meetings, plans, assignments and perhaps access of new energy and inspiration. This would all be done, however, with the intensely disturbing thought in the minds of the more intelligent of the planners that they may well be overlooking the one small field in which the true pathway is to be found or the one investigator, whose mind contains the seed of the great discovery.

I wouldn't for a moment decry the value of assessment of knowledge and its deficiencies in such fields as cancer and other presently incurable disabilities of man; of the value of frank exchange of information and ideas, or of the value of friendly collaborations—all of which can be encouraged and promoted by enlightened financial aid.

What I emphatically decry is the notion that organization can do what only creative genius can do and forgetfulness of the fact that organization and financing have it in their power actually to inhibit creative genius.

It is not my purpose to advance more arguments before your committees in favor of the establishment of a governmental organization designed to foster the growth of science in this country. Wiser men than I have already done so and I am in heartiest agreement with what they have said. With one reservation, however, viz: If the design of organization does not take full account of the peculiarities of the individual human unit of science, the investigator, and if the organization is not staffed by men who understand him and his problems, it might better not be undertaken for it will surely fail.

It is also not my purpose to include in this statement a discussion of what I deem to be the relative merits of the two working drafts which are before us. I wish to say however, that the contemplated

legislation represents the plan of a great experiment, one of the most important the country has ever undertaken; that investigators commonly agree that in planning a complex experiment in which are numerous variables it is unwise to begin with the details of the course of the experiment rigidly outlined; early results so often necessitate change of plan. The bill in which principles are stated with greatest clarity and in which organization and administration have greatest flexibility is, in my opinion, the bill to be desired.

One further point needs emphasis. The Congress and the people should be made to know that results which excite the popular imagination may well be infrequent and slow in coming. People must learn to be content with the assurance that a broad campaign against ignorance is being conducted by those who best understand how science advances and that time is essential for its results to become apparent.

Senator CORDON. I am impressed with your testimony, Dr. Richards, and particularly your differentiation between what is generally termed basic or pure science, and applied science. I think you made it wholly clear as to what that differentiation is, and the approach that should be made by the Government in the case of each.

Now, Doctor, have you any suggestions, specifically, as to either of the bills which we are here considering, or their provisions, or any changes therein?

Dr. RICHARDS. The two bills have been discussed in the committee itself, the Committee on Medical Research, and I have invited opinions from randomly selected investigators, to the number of some 30 or 35, chosen from different parts of the country, including those who I thought would be most critical of what the Committee on Medical Research had accomplished. Practically without exception they share my belief that the provisions of the Magnuson bill more nearly conform to the principles which we all hold than do the provisions of the Kilgore bill.

Senator CORDON. Doctor, if you, after further study, have any thoughts with reference to any changes that should be made, in either bill, as to the organizational set-up, or the method of procedure, I am sure the committee would be happy if you would present them to the committee in writing.

Dr. RICHARDS. I will be glad to do that.

Senator CORDON. Have you one or two short questions, Mr. Schimmel? We have a rather heavy schedule.

Dr. SCHIMMEL. Dr. Richards, as I understood your statement, you laid a great deal of stress on the safeguards which should be taken to protect pure research. Do you also believe that the proposed foundation should lend its support to applied research in the field of medicine, in the postwar period?

Dr. RICHARDS. Yes; certainly there is a place for it and both bills and the Bush report included that. But the point I wanted to make was, that if we utilize the scientific personnel of the country in order to foster applied research, we shall become sterile.

Dr. SCHIMMEL. But the conditions for the granting of funds should be different for the basic and for the applied with much more specific designation for funds in the case of the applied.

Dr. RICHARDS. Yes, but the investigators themselves ought to have their feelings consulted in all these things, because they are the ones who do the job.

Dr. SCHIMMEL. You would say the scientists who want this program are very much concerned that there be no foundation in Washington that regiments them as far as specific techniques of scientific research are concerned?

Dr. RICHARDS. Absolutely.

Dr. SCHIMMEL. Regardless of what is the top organization, that is the one thing they want to be absolutely certain of?

Dr. RICHARDS. Right.

Dr. SCHIMMEL. One last question. Is it the general thought of scientists in the medical field that there should be as rapid and free a publication of the results of research in the field of medicine?

Dr. RICHARDS. By all means. That has been a tradition for hundreds of years. That was to some extent interrupted during the war, in some cases unfortunately so, but certainly that is a complete desideratum.

Dr. SCHIMMEL. Isn't penicillin an outstanding example of a drug on which there were no proprietary patents, which came into rapid use with a great many manufacturers participating in its development?

Dr. RICHARDS. Yes; it certainly is a conspicuous example, but in CMR's capacity as adviser to the Commissioner of Patents under the wartime secrecy laws, we know that manufacturers protected their processes in the manufacture of penicillin by filing many applications for patents on their individual processes. As I recall there were over 100 cases referred to CMR for review and recommendation.

Senator CORDON. Thank you very much, Doctor. Our next witness is Dr. Francis Blake, of the Yale University School of Medicine. Dr. Blake.

I assume, Doctor, you would prefer, as far as possible, to complete your major statement without questions?

Dr. BLAKE. Yes.

Senator CORDON. Will you just go ahead, please?

TESTIMONY OF FRANCIS G. BLAKE, DEAN AND STERLING PROFESSOR OF MEDICINE, YALE UNIVERSITY SCHOOL OF MEDICINE

Dr. BLAKE. I shall confine my remarks to comments on the importance of fundamental research in the progress of medicine, on the one hand, and on the other, to the place of the medical schools and universities in medical research. In addition I propose to state briefly what I conceive to be the necessary procedures and safeguards, if medical research is to be fostered, developed, and expanded in the most productive and useful fashion through the aid of Federal funds.

Much of what I have to say is based on 30 years' experience as a teacher and research worker in clinical medicine and more recently, through an intimate acquaintance with the operations of the Army Epidemiological Board, on experience with methods by which Federal funds may be used through contracts with universities with adequate safeguards for the freedom of inquiry, the display of imagination, and the exercise of initiative so essential to productive scientific research worthy of the name.

Dr. Richards has already recited the many remarkable, even spectacular achievements of medical research, and the useful applications

of the new knowledge deriving from this research, in preventive and curative medicine during the war. He has pointed out the highly important contributions of the Committee on Medical Research under the Office of Scientific Research and Development in this accomplishment.

If I may, I would like to modify the next sentence slightly, after hearing Dr. Richards' testimony.

He has clearly stated the need for an expanded program of medical research and has expressed agreement with others who have advanced arguments in favor of the establishment of a governmental organization to foster the program of science in this country.

I accept without hesitation the force of his arguments for the need of Federal support, provided appropriate safeguards are set up in the procedure adopted for implementing this support—a procedure which should not contain within itself the seeds of self-defeat.

Indeed I would go further than call it need and venture to express the opinion that Federal support of scientific research in our medical schools and universities, particularly of so-called basic or fundamental research, which envisages no immediate practical result, presents a challenging and compelling opportunity for Government to foster the public welfare in an area of action in which we can no longer afford to lag behind.

Conspicuous examples have been given of the spectacular accomplishments which can issue from planned, organized, and coordinated medical research directed toward the solution of specific practical problems. Such accomplishments, however, do not constitute a valid argument that other unsolved problems of medicine, such as the prevention or cure of cancer, cardiovascular disease, and other degenerative diseases can be as expeditiously solved by a similar approach. A great deal of basic knowledge of living tissues will perhaps have to be won before these bastions of disease can even be attacked intelligently.

Moreover, I am constrained to express a considerable, and I hope a healthy, degree of skepticism that scientific research workers can profitably be deflected from their intrinsic interests into other fields of organized research. We must not forget that the undeniably successful record of medical research during the war, though impossible without the generous expenditure of Federal funds, would have been impossible without our great reserves of basic science. No amount of money, in the absence of these reserves, could have accomplished the desired result.

These reserves were:

(1) The accumulated scientific knowledge derived from years of fundamental research in the basic sciences of physics, chemistry, biology, physiology, pharmacology, bacteriology, immunology, and so forth, upon which innumerable advances in scientific medicine depend and without which the even reasonably prompt solution of practical problems in the prevention or treatment of disease would rarely be possible.

(2) The ready availability of numerous scientific research workers experienced in medical research, who had been trained in our colleges, universities, medical schools, and teaching hospitals during the last three decades prior to the war and who under the necessities of the war were willing to be diverted from their own work to the solution of problems essential to its efficient and successful conduct.

(3) The existence of university, medical school, hospital, and research institute laboratories and other facilities immediately available for utilization, even though often inadequately equipped and staffed for the purposes required. Here emphasis must be placed not only upon the basic scientific equipment, but also upon the clinical facilities: Hospital beds filled with hospital patients, and cared for by specially trained and interested physicians, for the hospital is the final testing ground for all medical theory.

Of these three aspects of medical research, the first, namely the background of fundamental knowledge in the scientific fields basic to clinical medicine, is so important that I would like to elaborate upon it.

IMPORTANCE OF FUNDAMENTAL RESEARCH TO THE PROGRESS OF MEDICINE

Medical research, in the broadest sense, includes all scientific research which has a bearing on medicine. It may be pursued in a variety of ways and by the utilization of a great variety of scientific techniques. It is often classified as being fundamental research or practical applied research, although the methods used in both types of research are in essence quite similar. In both the investigator has an idea, he is curious about something, and desires to satisfy his curiosity by seeking a solution to his problem through experiment. He wishes to see whether his idea is correct or not. In so-called fundamental research he is curious about something the solution of which has no immediately obvious practical value, what the late Walter B. Cannon called "curiosity research." He wants to understand the fundamental mechanisms of human physiology; the mechanism of an enzyme; the shape of a protein molecule; the effect of electric force on diffusion; the pattern of electric currents given off by the brain; or how fish live in salt water, or seals, or whales.

In the intermediate zone are problems which at one moment appear to be fundamental, at the next, practical, such as the cause of a certain strange pathological lesion; the characteristics of bacteria or viruses or other agents of disease; the nature of the conditions which determine epidemics, the why's and wherefore's of parasites.

In so-called applied medical research the investigator seeks to answer questions, the solution of which may be practically applied to the prevention, the amelioration or the cure of disease. Basic or fundamental research, though aimed at answering specific questions, is very likely to lead to new ideas, entirely new conceptions, which will completely reorient the direct attack on practical problems of medicine. Applied or developmental research may provide answers to practical problems of great importance, but there it is apt to stop. It rarely leads to new ideas of fundamental importance. Both methods are important and should go hand in hand, but fundamental research is essential and must come first, for it is the source of new facts and new ideas and more new facts, which can then be profitably utilized in the elucidation of the practical problems of medicine.

Without the curiosity of a Fleming when he noticed that a contaminating mold inhibited the growth of bacteria on a culture plate, the subsequent developmental and practical research on the therapeutic applications of penicillin would presumably not have occurred. Nor would we have had penicillin had Fleming not had the freedom

to putter away with this curiosity to his heart's content. And without years of previous fundamental research in bacteriology by numerous investigators, often unconcerned with practical problems of medicine, Fleming would not have had the opportunity to notice the contaminating mold and its inhibiting effect on bacteria in the first place.

Let us consider the practical use of gamma globulin for the prevention of measles and of infectious hepatitis, both applications being the result of Government-financed research sponsored through the Committee on Medical Research and the Army Epidemiological Board. Had not many years of fundamental laboratory research on animal and human antibodies preceded, it probably would not have occurred to Chapin and Richardson in 1919 to see whether convalescent measles serum would prevent measles. No further significant practical advance resulted from this observation until Cohn, as the result of years of research on the physical properties of proteins, separated a pure globulin from plasma. This pure globulin has now found practical application in the prevention of measles through the applied research of Stokes, Janeway, and their collaborators, and more recently in the prevention of epidemic infectious hepatitis or jaundice through the studies of Stokes, Paul, and their colleagues.

Innumerable examples of this sequence of events, from fundamental research to applied and developmental research, and thence to the prevention or treatment of disease, could be cited.

As so clearly and eloquently stated in the report of the Palmer Medical Advisory Committee to Dr. Bush:

> Discoveries in medicine have often come from the most remote and unexpected fields of science in the past; and it is probable that this will be equally true in the future. It is not unlikely that significant progress in the treatment of cardiovascular disease, kidney disease, cancer, and other refractory conditions will be made, perhaps unexpectedly, as the result of fundamental discoveries in fields unrelated to these diseases. * * * Further progress requires that the entire field of medicine and the underlying sciences * * * be developed impartially.

Now, research in medicine, both fundamental and applied, basic or clinical, may be carried out effectively in several ways: first and most importantly, in my opinion, by the individual investigator possessed of curiosity, imagination, and technical competence, who at the same time has the opportunity to attack the problems which arouse his own interest, the freedom to redirect his research as the course of his experiments may dictate; who is under no immediate compulsion to arrive at a practical answer to a practical problem. Depending on the nature of the problem he may work alone or gather about him a team of research and technical assistants or even may endeavor to coordinate his attack on the problem with that of other investigators working on the same or other aspects of the same general problem. It makes little difference. He is the spark, the guiding hand, the source of ideas. Freedom and flexibility are the essence of the method. By it most of our important fundamental discoveries have been made.

The second method is by a planned and coordinated attack on a particular problem or a particular disease, usually with a practical end in view, sometimes initiated by the sponsors with promise of financial support, sometimes initiated by the investigators as a means of acquiring financial support, depending upon whether money is to be dispensed or obtained. The method has merit and a fine record of

accomplishment under particular circumstances, such as war, when the emergency require, the deflection of men from their intrinsic interests. The development and testing of penicillin may again be cited as an illustrative example, but let us not overlook the fact that one of the most important uses of penicillin was not envisaged in the original committee planning but came out of the curiosity, imagination and initiative of one investigator who had the courage to step out of bounds to see what penicillin might do in the treatment of syphilis. Nor should we forget that the skepticism and persistance of another investigator, who refused to accept the committee's dictum that penicillin was of little value in the treatment of subacute bacterial endocarditis, an almost invariably fatal infection of the heart, has forced acceptance of the fact that many cases can be cured, if large enough doses are given over a long enough time. Planned and coordinated group research supported by term grants through contract or otherwise can have great value, despite the inherent hazards that it may stifle initiative or divert investigators from their primary fields of interest and competence. Yet these dangers can be avoided, if the purposes of the grant are not too narrowly defined, are sufficiently broad and flexible. This, I think, may be illustrated by referring to the operations of the Army Epidemiological Board. This Board of seven civilian scientists experienced in the broad field of infectious diseases was set up under Preventive Medicine Service in the Office of the Surgeon General in January 1941, under the rather imposing and cumbersome title of the Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army. The use of the words "investigation" and "other epidemic diseases" at once indicates the flexibility and breadth of the conception that lay behind its establishment.

Under the Board 10 commissions were organized, such as the Commission on Influenza, the Commission on Acute Respiratory Diseases, the Commission on Tropical Diseases, the Commission on Measles, the Commission on Neurotropic Virus Diseases, and so forth. Membership on each commission was made up of men known to have already exhibited interest and competence in the investigation of the diseases represented by the title of the commission to which they were attached. To the members of each commission was delegated the responsibility of drawing up their own plans for research, the central Board serving only in an advisory and not a directive capacity. Through contracts with the universities to which the directors of the various commissions were attached, funds were made available for research either in the university laboratories or in the field, both in this country or overseas as the situation demanded. Furthermore, I wish to point out that while the fields of activity of the various commissions might appear to be somewhat restricted as indicated by their titles, this has not been in fact the case. The administration of the Board and the terms of the contracts were purposely so flexible that it has been possible to use the talents of the members to investigate any problems of epidemic disease that were of interest and importance to the Army. By way of illustration let us take the Commission on Neurotropic Virus Diseases under the directorship of Dr. John R. Paul, of Yale. It might be supposed that it would be engaged in research on infantile paralysis and the various forms of encephalitis, and so it has been, but it has also gone far afield and made important

investigations of sand-fly fever in the Near East, of infectious hepatitis in North Africa, Sicily and Italy, and of dengue in the islands of the Pacific, as well as carrying on basic research on these diseases in university and hospital laboratories at the Yale School of Medicine, the Rockefeller Institute in New York and at Princeton, the University of Cincinnati, and the University of California, all under a flexible Government contract with Yale University. Similarly the Commission on Measles under the directorship of Dr. Joseph Stokes, Jr., under Government contract with the University of Pennsylvania, has not only made important contributions to methods for the control of measles but has also spread out to include valuable research on mumps and especially during the last 2 years both fundamental and practical research on epidemic hepatitis.

I need not cite other examples nor elaborate this particular subject further. The important points which I have tried to bring out are the importance of fundamental research to the progress of medicine, the necessity for safeguarding individual freedom and initiative in research, irrespective of whether it be fundamental or applied, and the merit of planned, group research provided it is recognized that flexibility is a sine qua non and that "discovery cannot be achieved by directive."

THE PLACE OF MEDICAL SCHOOLS AND UNIVERSITIES IN MEDICAL RESEARCH

The medical schools and universities of this country have contributed much, if not the bulk, of medical research in the past and will undoubtedly continue to contribute to the limit of their available personnel and facilities. They have also carried the responsibility of training competent investigators and this they will continue to do to the best of their ability. And it is through the clinical staffs of the medical schools that a large part of the clinical, or hospital, studies are carried out.

The main obligation of the medical schools, as in the past, will doubtless continue to be that of providing the individual research worker with an opportunity to investigate those problems of medicine which have attracted his interest and stimulated his curiosity and imagination, a responsibility which cannot be shifted elsewhere. At the same time there undoubtedly will be groups of investigators in our medical schools who may desire to undertake a coordinated attack on a particular problem. In either case the support of scientific research in medicine by Federal funds through grants or contracts with medical schools or universities is a worthy plan.

At least three methods of approach are available and I state them in what I conceive to be their relative sequential importance at the present time.

(1) Provision of unrestricted funds to medical schools to enable them to build up and strengthen their teaching and research personnel, their laboratory facilities, and their equipment. This is currently the most dire need of all medical schools, of some more than others. Without it they are in no position to expand their activities in the training of new research workers of the oncoming generation, even though unlimited fellowship funds be provided for the support of advanced research fellows; they are in no position to expand their

own research programs in special fields of medicine, whether fundamental or applied, even though large sums be made available through term grants or contracts for particular, well-defined projects.

(2) Provision of funds for scholarships and fellowships. The need for replenishing the deficit of trained research workers which has taken place because of the war has been stated many times. This matter cannot be too strongly emphasized, it is probably the most important task ahead of our universities and medical schools during the ensuing decade. Mere replacement, however, is not enough. A greater number of specially trained investigators is needed in all fields of medicine. The costs of their research work, as well as their personal salaries, must be supported. In brief, more specialist, research manpower hours are needed. These medical fellowships should, of course, be administered through a Division of Medicine.

(3) Grants-in-aid are needed for a limited and well-considered number of research projects, both of immediate and long-range importance.

The first procedure—i. e., provision of adequate unrestricted funds for general purposes—is the prerequisite foundation stone for the edifice. Without it the superstructure of research fellows and grants-in-aid for project research cannot be fully productive. With it, research fellows can be trained in the methods of discovering, tackling, and solving research problems; and the demand for new personnel in medical research can be met. Given the men and the tools to do the work, given the men to be trained through the assistance of scholarships, fellowships, and postdoctorate assistantships, medical research will almost automatically expand and flourish.

If to these two fundamentals, which must take precedence in any well conceived program for the expansion and acceleration of scientific research, whether in medicine or physics, chemistry or biology, there be added grants for the support of specific research projects of merit, the purposes envisaged in the program for Federal support of research, namely "to promote the progress of science and the useful arts; to secure the national defense; to advance the national health, prosperity and welfare" can be assured.

My statement is in essence a plea that the implementation of Federal support for medical research be so devised that the proposed National Research Foundation be conceived as a body whose main function is not to plan, coordinate or direct research, but rather to foster and protect individual and institutional freedom of research, and to foster individual initiative, and that driving curiosity which compels research workers to seek the solution of problems which intrigue them. In my opinion the provisions of the Magnuson bill (S. 1285) more nearly meet the requirements of safeguarding institutional and individual liberty in research, and of wise administration, than do other pending bills.

Senator CORDON. Thank you very much, Doctor. I am sure that the committee will be greatly helped in its consideration of this important matter by your statement.

I am particularly interested in your suggestions at the closing of the statement, which are specific.

Now, do you have, Doctor, any suggestions for any changes, modification or amendment in any of the pending bills that would make such bill more practical in its application, more certain of achieving the end it sought?

Dr. Blake. The only comment I think I would like to make is that I believe there seems to be a little confusion in the Magnuson bill with respect to the relationships of medical research and biological research, by which I mean botany, zoology, and similar fields of biological research.

Senator Cordon. Doctor, at your leisure, I hope that you will consider carefully studying the bill, the particular sections referred to, and of making in writing such suggestions as you feel will improve the bill and clarify it. The committee would be most grateful if you would do that.

Dr. Blake. I would be glad to.

Dr. Schimmel. Do you feel that particularly in the medical research it is important to have a full, rapid, and free publication of the research results of the public funds?

Dr. Blake. I would certainly take that view. I think it has always been the view of medicine, and I am sure that my attitude toward it is exemplified by the procedure which we have followed with the research work done on the Army Epidemiological Board, in which all the work that has been done has been published just as promptly as possible.

Dr. Schimmel. And freely.

Dr. Blake. Yes.

Dr. Schimmel. So it wasn't tied up.

Dr. Blake. There have been no restrictions and no patents.

Dr. Schimmel. My other question concerns the top organization. I gather you are very concerned that there be no foundation which exercises a bureaucratic control or regimentation of the work of the men who get the funds?

Dr. Blake. In my opinion the top organization should be advisory and so devised as to foster and help rather than to direct and to coordinate and organize research.

Dr. Schimmel. Now in that question, isn't it true that for private funds, the way you have the greatest assurance of broad representative participation in the final decisions of a foundation is to have a well represented group on the board, with an expert administrator underneath them?

Dr. Blake. I would agree with that.

Dr. Schimmel. Now, in the case of the Government, wouldn't it be most important to have the organization, which is most sensitive to criticism, to change when any type of bureaucratic control develops?

Dr. Blake. I would again make a plea for flexibility in the organization. I would agree with Dr. Richards' statement that the proposed Research Foundation, in peacetime, must be looked upon as a new experimental enterprise, and cannot very profitably be compared with what is done under the compulsions of war for the immediate solution of practical problems.

Dr. Schimmel. One consideration in your view would be that it would be sensitive to public opinion if any bureaucracy should develop in the administration of science.

Dr. Blake. I am not sure that I can answer the question of sensitivity to public opinion.

Senator Cordon. All you need to do is serve a term in the United States Senate, and you will fully understand. [Laughter.]

One other question, please, Doctor. Your final statement was to the effect that the organization or agency, administering the foundation, should have as its main function the fostering and protection of the individual, institutional freedom of research, rather than that of planning, coordinating, or directing research.

I take it that you do not mean by that that such agency should not have the obligation and the responsibility of determining what special research should be directed or what grants and aids should be made for special purposes.

Dr. BLAKE. It would naturally have fiscal responsibility, to determine its distribution of the funds.

Senator CORDON. And the purpose for which those funds were to be spent, as, for instance, if you desire to forward study with reference to cancer, or any other specific disease?

Dr. BLAKE. I think it would be very unfortunate if the central board was so constituted that it, whether under popular pressure or otherwise, directed its major efforts toward the dispensing of funds for the solution of immediately practical problems, through applied research.

Senator CORDON. Well, I understand that you recommend that as one of your steps.

Dr. BLAKE. Only as the third and least important step.

Senator CORDON. But it is one of the steps, and I take it if that is to be one of the duties of the Board, then the Board to that extent must give consideration to the relative importance of specific problems and determine which of those should be supported.

Dr. BLAKE. Certainly.

Senator CORDON. Now you made a statement also, and I quote:

> Planned and coordinated group research, supported by term grants, through contract or otherwise, can have great value, despite the inherent hazards that it may stifle initiative or divert investigators from their primary fields of interest and competence.

Would you elaborate on that statement?

Dr. BLAKE. What I mean by that, I think, is illustrated by the diversion, and quite properly, during the war, of many scientific investigators from the particular fields of research which they had previously been engaged in, and were particularly interested and most competent in. I think if such a method of procedure were followed in peacetime it would be unfortunate.

Senator CORDON. Do you feel, Doctor, that the emphasis should not be placed upon that type of research, but that it does have a place in an over-all program?

Dr. BLAKE. Yes.

Senator CORDON. Thank you very much.

The next witness will be Dr. John P. Peters, of the Yale School of Medicine.

TESTIMONY OF DR. JOHN P. PETERS, YALE SCHOOL OF MEDICINE

Dr. PETERS. Experience in the last generation has shown that a single scientific advance in our knowledge of the causes and treatment of disease may do more to decrease morbidity, disability, and mortality from disease than indefinite multiplication of personnel and facilities. With all due credit to the organization of the military medical forces

in the war just ended, the low disability and death rates can probably be attributed less to this organization than to a few notable scientific discoveries.

In the war the importance of efficient, productive manpower became so obvious that the Nation had to take cognizance of it and through its Government take steps to preserve it. It became evident also that the disability of a single person from illness or injury immobilized others and, when multiplied, clogged communications and tended to paralyze operations. In times of peace manpower is equally an asset, disability equally a liability, although this is not forced upon our consciousness as it is in the urgency of war or other great crises. In peace as in war, disability from disease or injury is not altogether a personal matter, It invariably affects others in the environment of the disabled person and, in the aggregate, becomes a burden to the community. For this reason the public as a whole cannot afford to neglect it. In point of fact, the Government has always assumed some responsibility toward the sick and injured in its population, but chiefly in the most uneconomical manner. It has borne the burden of the ultimate disastrous effects of injury and disease. It would seem more humane as well as economical to spend greater effort in seeking methods by which disabilities might be prevented or better corrected.

For several reasons it seems no longer feasible or good policy to leave the advancement of investigation and discovery entirely to private agencies. Even if the well-springs of humanity are not drying up and the resources of philanthropy nearing exhaustion, as some fear, philanthropy is too casual and too emotionally activated to advance effectively a concerted program of medical investigation. Although commercial organizations have made important contributions, their efforts must needs be directed chiefly to exploitable objectives. The contributions which have the greatest long-term value, however, those which revolutionize practice, are usually the products of fundamental research directed to no immediately practical end. But these reasons are infinitely less significant than the fact that, on the whole, the resources of philanthropy and commerce have been, and presumably will continue to be, directed to the promotion of projects rather than to the development of men. This has been especially evident in medicine because of its emotional appeal. Fabulous sums have been spent to buy the secrets of the cause and cure of cancer, as if this required only the multiplication of buildings, technicians, and test tubes. Scientific discoveries seldom, if ever, come from the dreams of promoters: They are products of the painstaking labors of highly trained men with imagination, intelligence, and critical judgment. The advancement of science requires, first, the selection and development of such men; second, that these men be given continuous opportunity to exercise their faculties in investigative work and in the multiplication of their kind by educational activities.

Never was this last more important than at the present moment, when education has been paralyzed for half a decade. Much publicity has been given to a few outstanding achievements of medicine in this war. Many have labored under the misapprehension that these were evidences of continued scientific progress and development. They represent the products of a passing generation, prepared before

the war and spurred to redoubled and specifically directed activity by its urgency.

Behind them, because of the military inroads upon the educational system, has been left almost a vacuum. Because of the peculiar utility of physicians to the military forces, no profession suffered more than medicine in this educational infanticide. We cannot afford to lose a generation of medical scientists, especially when it is realized that upon this lost generation we must depend for the education of their successors.

This is not a problem that can be left either wisely or equitably to the chances of philanthropy and commerce. Even if public policy did not demand that some provision be made for the rehabilitation of medical science, responsibility to this generation for which we have ostensibly fought, chiefly at their own expense, demands that we restore to them in some part and by national effort the opportunity to participate in and enjoy the fruits of scientific advance. I do not mean to plead for veteran's preference. The only criteria for the selection of scientists are character and intelligence.

For those qualified by character and intelligence for the pursuit of scientific investigation it is a national obligation and therefore a proper governmental function to expand opportunity.

This point, the development of men, though recognized in the original drafts of both S. 1297 and S. 1285 and in the amendment of S. 1297, is, I believe, not given the emphasis and priority it deserves. Scholarships and fellowships awarded for a single year without opportunity for renewal are not adequate. Even if they are renewable, they cannot alone achieve the desired object. The value of a scholarship or a fellowship depends in large part upon the character and facilities of the person, department, or organization under which the incumbent works.

Difficult as it may seem, some formula should be found by which funds, facilities, and personnel may be made available to outstanding persons, departments, or organizations for the general pursuit of scientific investigations. This would not only permit these persons, departments, or organizations to increase and accelerate their research activities; it would also enhance the value of fellowships under these persons or in these departments or organizations. This may be the intention of any or all of the bills under consideration, but the wording of these bills might be interpreted to mean that such persons, departments, or organizations could receive grants only through contracts for project work. This would require that work under these grants be directed to prearranged specific objectives. This, in turn, will tend to channel the work of the persons, departments, and organizations toward these same objectives and to divert the activities of holders of scholarships and fellowships from the broad development of their talents and interests into the narrow channels of these projects.

Among the most important considerations in the establishment of an effective program for the promotion and support of scientific research are the provisions for the direction or control of this program. In S. 1297 the provision for a board, half the members of which shall be ex officio appointments, is most unfortunate. These members will be administrative officers, or their representatives, charged with the promotion of certain practical objectives. Since the conduct of scientific research in their departments is a concern of the board, they will be suitors to the board on which they must serve as advisers. Pre-

sumably other members of the board would be appointed because of their competence as scientific advisers and consultants; there is no assurance that this would be true of ex officio members. Nevertheless, the latter would be at a great advantage, because their duties on the board would be part of the functions of their positions and because of their location in Washington; while for the public members the conduct of their duties on the board would be avocational and geographically remote from the places of their normal occupations. Administrative officers or their representatives might be given the privilege or right to sit with the board and the various divisional committees but should not have voting privileges. An exception to this rule might be made in the case of the divisional committee on national defense.

In S. 1297 the board has only advisory functions, authority being vested in a director appointed by the President. In S. 1285 the director is appointed by, and an instrument of, the board in which authority is vested. Objections have been raised to the formula of S. 1297 because this would make of the director a practical dictator. To me it seems far more important that it would locate responsibility where it could be held to account. A large board is a clumsy executive and administrative organ, and much of the work of the foundation will be executive and administrative. In any case, the action of a voluntary or part-time board is likely to become chiefly consultative or advisory; of necessity it is discontinuous. The paid agent or instrument of this board, whether he be termed "director" or "secretary," functions continuously and must be entrusted with the management of the administrative machinery. His efficiency and the activities of the board are likely to be inversely related to one another. If he is highly efficient and the members of the board are proportionally dilatory, the agent becomes just as much dictator as if the authority had been entrusted to him in the first instance. But since he is only an agent of the board, he cannot be held directly accountable for his actions. Responsibility is dispersed. Such a project as this should not be conceived in a spirit of distrust. After all, the character of both director and board will depend upon the proper exercise of appointive powers. It is not improbable that appointments to an authoritative board would be subject to more pressure than appointments to an advisory board. The fear that a director might bypass an advisory board can be obviated by the introduction of two types of provisions: First, the clauses demanding that he consult with this board may be strengthened; second, the advisory board may be empowered to present its recommendations and criticisms to the President, the Legislature, or the public. Positive provision for such appeal should be incorporated in the bill. Any intelligent director would hesitate to evade or controvert such an authoritative board as is contemplated in these bills if he knew that he would be arraigned before the bar of public opinion for his acts. This seems to me the democratic method. Some may claim that science and scientists occupy an exceptional position and should, therefore, be treated in an exceptional manner. Such exceptions are dangerous in politics and Government, in which precedents are given great weight.

It may be unrealistic to assume that the members of the advisory board can give the time required for the conduct of their duties gratuitously. Remuneration for services on a per diem basis might be advisable, if only to enable the Government to secure the most desir-

able persons. For members of the divisional committees such remuneration will be even more essential because it may be anticipated that they will be forced to devote much time to their work on these committees and will be drawn from a younger and less well established group than will the members of the board. The appointment of a salaried person as agent or director of each of these divisional committees, as suggested in the amended S. 1297, has something to recommend it.

The formula in section 2 (b) and (c) of S. 1297 and the amendment, which prescribes the proportional allocation of funds between the divisions of the foundation, embodies a bad principle. It establishes permanently the division of resources on what seems at this particular moment an opportune basis. It is impossible to predict the relative needs of national defense, medical sciences, and the basic sciences in a critically changing world. This is the very kind of question that should be left to a well-chosen advisory board. If some kind of formula cannot be escaped because of the pressure for such a prescription, it should be framed in less ambiguous terms than those of S. 1297 section 201 (b) and (c) (amendment sec. 4 (b) and (c)). These paragraphs were presumably intended to assure an adequate proportion of the funds for national defense and the medical sciences and to limit the amounts that could be given to commercial organizations. As they are at present phrased, if the factions allotted to medical sciences and national defense were all granted to nonprofit institutions only 10 percent need be given to nonprofit institutions for the support of the basic sciences. It has been claimed that the 50 percent refers not to the total, as the bill states, but to each of the categories. It would be well if this were clearly stated. If the bill is intended to accelerate the advance of science and the development of scientists, however, this whole limiting section should be either deleted or written in broader terms lest it compromise the natural evolution of the program.

The provisions for complete publicity should meet the approval of all scientists. It must be a source of regret that there should be any necessity for exceptions to this rule. Restrictions on the free circulation of knowledge not only delay progress; they may also protect incompetence and prolong error. In medical sciences, at least, there should be no secrets.

Senator CORDON. The committee is most appreciative of your statement, and particularly of your considered opinion as to the various provisions of the bill, and your suggestions as to modification. This is a new field to this committee, and a new field to the Congress, and to the Government, and one of the purposes of these hearings is to gather the most widely known authorities in this country in the several fields and to secure from them their opinions as to the best procedure to adopt.

I should like to have more time that I have. I should like to have you develop further some of the suggestions you have made. But due to the limited time, I am sorry we can't do it. I hope, Doctor, if after a further study and consideration of the bill, you do have further suggestions, that you will reduce them to writing and file them with the committee. They will be most welcome.

Dr. PETERS. I shall be glad to do that.

Senator CORDON. Thank you very much, Doctor.

The next witness will be Dr. Cornelius P. Rhoads, of the Memorial Hospital of New York.

TESTIMONY OF DR. CORNELIUS P. RHOADS, MEMORIAL HOSPITAL, NEW YORK CITY

Dr. RHOADS. (Director, Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York, N. Y.; Director, Sloan-Kettering Institute for Medical Research, New York, N. Y.; Chairman, National Research Council Committee on Growth; Professor of Pathology, Cornell University Medical School, New York, N. Y.) The subject under discussion is Federal aid for medical research. Two questions are involved: whether Federal funds should be made available at all, and, if they are made available, how they can be distributed in order to yield the greatest return.

A number of distinguished individuals have already testified on these questions. The record of their testimony shows a unanimous conviction that no strings should be attached to the spending of this money. They believe that it should be turned over to the universities and scientific institutes. They hold that if this is done it will provide educational opportunity and will allow the scientist to work in any field of his choosing. They are sure that only in this way will revolutionary discoveries be made. If there is to be Federal support we must establish clearly the need for more medical research and the probability that this added effort will result in a good return in terms of reduced rates of illness and death.

Is there evidence that the problem of disease is serious enough to justify a major scientific effort? Consider the facts. The deaths from cancer still number over 160,000 individuals each year. Ninety-one thousand die of stroke (cerebral hemorrhage), the same number from diseases of the blood vessels of the heart (coronary disease), 67,100 from chronic kidney disease and 221,000 from chronic heart disease.

When one considers not only the toll of death but also the misery which results from lingering, disabling, chronic but not fatal illness, the total burden upon the country represents a major problem. It certainly is one deserving of the most intense application of the best scientific talent available.

What are the chances of success if this application is made? Experience has already proved that they are good. For example, in the 5 years from 1933 to 1937, the average death rate for influenza and pneumonia for the first 6 months of the year was 114.6 per 100,000 or 148,000 individuals. For the last 5 years, three of them "influenza years," the rate in the first 6 months averaged 48.7 per 100,000. In 1945 it was only 37.5 per 100,000 or 48,000 persons, or 23 percent below this average. This extraordinary change has resulted from the dramatic discovery that infectious disease can be cured by certain chemical agents. Other advances are not so dramatic but are equally definite. For example the outlook for the control of cancer is definitely promising. "There is growing evidence that patients with cancer are seeking medical care earlier in the course of the disease and that their chances of survival have improved materially." (This is quoted from the July 1945 statistical bulletin of the Metropolitan Life Insurance Co., a particularly careful and well-informed organization). This means that even in the absence of a revolutionary discovery, general scientific advance on a broad basis has already reduced the death rate from cancer, a peculiarly baffling and tragic disease.

Let us concede, then, that the problem of disease is one of immense importance and that its solution probably can be obtained by scientific effort of the proper kind. What sort of effort is proved by experience of the past to be most likely to provide further advance in the future?

There has been much comment, both public and private, concerning the medical accomplishments of organized research during the war. No one can question to the slightest degree the value of these accomplishments. It would be foolish, indeed disastrous, to believe that a similar rate of applicable discoveries can be continued by the simple procedure of voting funds. During the war, much more than funds was available. There was at hand the call of duty, which brought into an intense scientific effort many individuals who without this call would have applied their energies and abilities to other types of work. There was available also the aid of a selective-service system, which left to the individual no choice but to cooperate. There was also the protective wall of secrecy and the precision of a military organization. These factors were important, but they are dwarfed by the importance of the fact that a broad background of fundamental knowledge existed which has not been converted into practical application. In short, during the prewar years discovery, the product of research, had moved ahead much faster than had its practical application, development.

From these facts it is perfectly apparent that to insure advances, two types of work are necessary. The first is the broad, free investigation which may lead to fundamental discovery. The second is the development of the results of discovery into practical application. Nearly all those who have testified have recommended procedures which will insure the freedom of initiative requisite for discovery. This has been done on the assumption that practical application will follow discovery automatically. Past experience indicates that this is not necessarily the case. Thirty years elapsed between the discovery that diabetes could be caused by removing the pancreas, a gland of internal secretion, and the practical application of this discovery—the preparation from the pancreas of insulin, capable of controlling diabetes. During the war, on the other hand, emphasis on practical application led into development scientists who might otherwise have been making fundamental discoveries.

From the evidence, it is clear that Federal funds must be expended for medical research in a way which will insure a nice balance between discovery and practical application. Unless this is done the funds will not have been put to the most effective use. The question is, than, how can this be done? There can be no doubt that financial aid must be given to universities and research institutes in order to increase the supply of trained personnel and to insure opportunity for them to make discoveries.

To maintain a balance between discovery and development requires the concentration of the best scientific thought on the work of the discoverers. This is a problem in organization. Much experience which bears upon this point has been gained by the activities of the research foundations. This experience should serve as a guide to the type of organization likely to be most effective in handling Federal funds. I am informed that these research foundations are unanimous in their endorsement of certain principles of organization. These principles are basically two: The first is that there must be set up a board or

commission which incorporates outstanding individuals with both lay and professional qualifications. The second is that a program of such breadth and continuity must be followed as will give opportunity for really important discovery and application.

I know of no research director who would have the temerity to commit his career to a program without the protection and guidance of a board of trustees. Scientific work is productive principally of failures, frustrations, disappointments, and misdirected efforts. Every success means thousands of failures. The responsibility of the handling of public funds is too great for any single individual to stand alone before the public as responsible for failures as numerous as are bound to occur if any real success is to be attained. In science, as well as in every other endeavor, omelets are not made without breaking eggs.

I wish to endorse emphatically the recommendation made by others that to insure discovery Federal funds be made available for the education of young scientists and for the support of free investigation. I wish to urge as strongly as possible, on the basis of every bit of evidence known to me, that the disposition of Federal funds for the support of research be placed in the hands of a commission of qualified individuals. I wish to urge, finally, that the qualifications of these individuals be established by the most experienced and most reputable scientific body in the country.

Federal funds for the support of research represent a tool of tremendous power. Properly handled, it should give advances more numerous and more important than ever attained before. Improperly handled, it will be disappointing and it might result in a serious set-back to the scientific progress of this country.

Senator Cordon. Thank you very much, Doctor, for your statement. You mentioned, in connection with the rapid advancement made during the war period, the fact that this was due somewhat to the fact that, and I quote, "There was also the protective wall of secrecy." Do you mean that there should be secrecy in connection with investigations in the medical field?

Dr. Rhoads. No, sir. I mean that it was possible for those directing scientific efforts during the war to take chances which they would not have taken had they not had this board of secrecy, and I am sure you have to take chances to make great gains in scientific discovery. I think there is no question of that.

Dr. Schimmel. Where do you contemplate the scientific cases would be made? Let's take, for example, in the case of medicine—at the divisional level or the top administrative level?

Dr. Rhoads. I cannot conceive of an organizatoin which would operate effectively without the decisions being shared by a commission who has supreme power to set policy, to set professional policy.

Dr. Schimmel. Where would the scientific decisions be made? Would they be made by a part-time commission at the top level, or by 20, 30, or 40 advisory committees at the divisional level?

Dr. Rhoads. By a top commission, on a part-time unpaid level. They would be implemented through a director, and the division would be made, I assume, upon the basis of recommendations to a number of advisory panels.

Dr. Schimmel. To get your thought, you think it is entirely practicable that the decisions should be referred to a top part-time commission on a specific scientific basis?

Dr. Rhoads. I do.

Senator Cordon. Doctor, you suggested that the qualifications of—rather, your suggestion was that the group charged with handling this agency should have the qualifications established, and I quote, "by the most experienced and most reputable scientific bodies in the country." Did you have in mind any particular body?

Dr. Rhoads. Yes, sir, the National Academy of Medicine. I have referred precisely this problem to that body, in order to have the best advice.

Senator Cordon. Thank you very much, Doctor.

(The following was submitted for the record:)

Report on Federal Support of Scientific Research by the Committee on Public Health Relations of The New York Academy of Medicine

Submitted by Dr. C. P. Rhoades

In the considered judgment of the committee on public health relations of the New York Academy of Medicine the following general principles should govern proposals to enlarge the area of financial participation by Government in scientific research work.

1. Support of research in medicine and public health by Federal funds is necessary and desirable.

2. Such support should be supplementary to that from private sources. It should not aim to supersede, diminish, or discourage private support.

3. The primary function of the proposed National Research Foundation should be to develop and finance and not to operate or control research activities. The paramount importance of fellowships and scholarships in the field of medicine and public health should be stressed.

4. The activities of the proposed foundation should not be construed as supplanting the scientific work which is being carried on by certain branches of the Federal Government.

5. Freedom of the individual worker and of the participating institutions should be assured through proper safeguards.

The committee is somewhat apprehensive lest the present tendency to emphasize combined or group research may jeopardize initiative and opportunities for individual creative expression. The position of those engaged in research without an immediate and practical objective may become insecure. Therefore, it is recommended that the policy pursued be clearly formulated to insure the availability of support both for combined or group research and for independent research by individuals.

6. The governing authority of the proposed National Research Foundation should be vested in a board appointed by the President of the United States. Its functions should be similar to a board of trustees of an educational or benevolent organization. There should be no ex-officio members on such a board. The board should have the sole authority and responsibility for the determination of policy. The executive officer of such a foundation should not be a member of the board, and his functions should be to carry out the policies of the board.

Of all the pending bills which deal with Government support of scientific research the Magnuson bill comes nearer than any other to being in accord with the above principles. The following changes, however, are suggested:

1. The Magnuson bill provides that a National Research Foundation be established "to develop and promote a national board for scientific research and scientific education" (sec. 2a) and "to initiate and support basic scientific research and scientific development in the medical, natural, and social sciences through contracts, grants, or other forms of assistance" (sec. 2b).

The above subsections should be modified in order to clarify the primary purpose of the foundation which is to support and integrate rather than to initiate or operate research. Substitution of the word "develop" for the word "initiate" would eliminate the implied domination of scientific research by the foundation.

2. Another purpose of the bill is "to discover and develop scientific talent, particularly in American youth" (sec. 2d). In the judgment of the committee it is not the task of the foundation to make discoveries of scientific talent; such discoveries should be left to educational agencies. It is suggested that the phrase "to discover and develop" should be changed to read "to encourage scientific talent by adequate grants."

3. The foundation is also "to foster the interchange of scientific information among scientists in this country and abroad; and to correlate the foundation's scientific research and scientific development program with those undertaken by public and private research groups" (sec. 2f, g). The committee is of the opinion that section 2f and g should be reworded so that a possessive spirit on the part of the foundation will not be implied. The following phraseology is preferred: "to foster the interchange of scientific information among scientists in this country and abroad; and to correlate the scientific research and scientific development programs sponsored by the foundation with those undertaken by public and private research groups."

4. The Magnuson bill provides for the establishment of "a national science reserve" in which those who receive scholorships and fellowships in science and medicine from the foundation shall be available for call into the service of the Government for scientific and technical work in time of war or other national emergency (sec. 7i). The committee does not consider this provision necessary or desirable since the Congress has the power to draft all men in time of war and since the provision makes the scholarships and fellowships conditional rather than free grants made solely in the interests of scientific research.

5. In the judgment of the committee close liaison should be maintained between the Division of Medical Research and the Division of Scientific Personnel and Education with regard to the granting of fellowships and scholarships (sec. 5a).

6. For purposes of clarity the section which provides that the members of the committees within each division "shall be appointed by the board after receiving recommendations from the National Academy of Sciences" (sec. 6a) should be changed to read that the members "shall be appointed by the Board upon the recommendation of the National Academy of Sciences."

The committee recommends that this report be submitted to the congressional committees now holding hearings on the pending legislation with regard to government support for the promotion of scientific research.

Approved by the committee on public health relations of the New York Academy of Medicine at its meeting on Monday, October 15, 1945.

E. H. L. Corwin,
Executive Secretary.

We now have a panel for discussion, consisting of Dr. Allan Butler, of the Massachusetts General Hospital, Dr. Robert P. Fischelis, secretary of the American Pharmaceutical Association, Dr. Ewan M. MacEwan, Iowa College of Medicine.

TESTIMONY OF DR. ALLAN BUTLER, MASSACHUSETTS GENERAL HOSPITAL

Dr. Butler. Mr. Chairman, I have been asked to emphasize certain points which my simple experience as a medical practitioner, administrator, teacher, and clinical investigator suggests to deserve the thoughtful consideration of those who are shaping the legislation that will create an effective National Science Foundation.

First, without in any way deprecating the importance of fundamental science in improving the medical care and health of society, I want to call attention to the importance of the clinical investigator. Though his role frequently falls under the category of applied science, he is in a strange way playing a fundamental role in basic science. Because of his contact with both clinical medicine and scientific thought and technique, he not infrequently has an interest that results in concepts that might not occur to the basic scientist. His experimental contributions, therefore, may open fields which the basic scientist may cultivate with great profit. A few of the many examples where the clinical investigator has made such a contribution to science as well as to health will suffice to illustrate this point.

Jenner, a country practitioner, contributed not only the practical means of controlling smallpox, but also an experiment which provided

basic concepts to the science of immunology. Long, a physician, and Morton, a dentist, determined the anesthetic value of ether and opened that field to the chemist and physiologist. Banting, an orthopedic surgeon and Best, a medical student, not only gave the millions of people afflicted with diabetes the means of controlling their otherwise fatal disease, but also information which the basic scientists could expand. Minot and Murphy, both clinicians, in discovering the effectiveness of liver in the treatment of pernicious anemia similarly contributed not only to the alleviation of human suffering, but also ideas which stimulated scientific work. The therapeutic value of the sulfonamides and the stimulus that it provided to the scientific development of chemotherapy might have been missed for years but for the work of Chruikshank, a clinician.

Physicians rather than scientists laid the foundation from which arose the recent advances in endocrinology and in the control of growth and development. Physicians contributed the imagination and initial observations that led to the recognition of the immunologic properties of serum which recently have been so ably developed by chemists, as described by Dr. Richards and Dr. Blake. Surgeons rather than pure physiologists made the major contributions in developing the knowledge which has resulted in the extraordinary advances in pulmonary and more recently in cardiac surgery. The ready visualization of what these advances have meant in saving the lives of our wounded may give the layman some appreciation of what they mean in peace.

In spite of this extraordinary record in research that has contributed so much to human happiness, provision for the adequate remuneration of the clinical investigator has thus far been almost ignored. In laboratories of clinical research, salaries of $1,200 to $3,000 can be provided quite readily. The provision of more is extremely difficult, and also on an unusually short-term basis. Too frequently their work is dependent upon a year's grant, whose renewal may not be determined until 2 weeks before its expiration date.

Thus, to meet their obligations to their families they must resort to practice, teaching, or commercial work at their very prime in medicine. Go over the whole country today and you will find but few individuals who, in the course of their desire to pursue clinical investigation, have not been forced to dissipate their energy on other things in order to earn a respectable living. Top positions in universities are open to the basic scientist, in which he can pursue his science. The clinical investigator, on the other hand, too frequently must give up his research and become a teacher, clinician, and administrator to be promoted to a professorship. Let's hope that somewhere in the National Science Foundation provision will be made so that this no longer is true.

An extreme and puzzling example of the unique position of the clinical investigator arises in a consideration of how invesgitation of the prevention and treatment of mental disease may be supported by a National Science Foundation. Are we to rely on the basic sciences to break through the impassés that now confront us in this field of clinical investigation? Or must we support the clinical investigator whose approach to the subject appears so unscientific to the scientist? I shall not attempt an answer, but will venture the guess that the contributions that will ultimately open this field to scientific exploration will come from the clinical investigator, not the basic scientist.

Pure science has no monopoly on imagination and ingenuity. Nor is it, of course, a goal in itself. Parenthetically, as Senator Fulbright has remarked early in these hearings, how ridiculous is the dilemma which science has presented. The science that increases our wealth and health at an extraordinary pace today forces us to become more scientific because science now threatens the mass destruction of wealth and human life. Democracy will have but little place in this world if political science lags so far behind our scientific achievement that the latter becomes the means of establishing and perpetuating dictatorship. In considering this legislation, one should not forget that the value of all science seems to be in the hands of social science.

The question of patents is peculiarly associated with clinical investigation. Those who object to the introduction of a patent clause in the present legislation are concerned with defending the profit motive. This they assert is a stimulus which is basic to competitive private industry. Of course it is difficult for university scientists or physicians to understand how that motive is so important a stimulus to scientific endeavor. For the record of the contributions which universities and medical scientists have made without recourse to a protection of profit by patents compares favorably with the record of competitive industry. Indeed it may be said that such introduction of patents as has occurred in their fields, the medical fields, has not been beneficial. The very serious disadvantages of patents to the pursuit of integrated scientific work has been demonstrated during the prosecution of the integrated scientific research which contributed so successfully to our war effort. Perhaps the importance of the profit motive was greater in a society of want than in one in which the science with which this legislation is concerned has so increased human productiveness. Surely under present economic and tax conditions, reliance on the profit motive as a stimulus to scientific accomplishment does not seem too sound.

I, therefore, urge that a clause be included in the present legislation specifying that patents covering work done under grants made by the foundation be dedicated freely to the public. However, provision should be made whereby an individual may ask and the foundation may make such exceptions to this general policy as may promote the purposes of this legislation.

In this connection mention may be made of a certain lack of reliance on or trust in our Government, which is reflected in some of the discussion of this legislation and indeed in much public opinion. It is odd that those who are advocating democracy as the form of Government to be adopted throughout the world have so little faith in democracy at home. Indeed, at a period where Government, whether we like it or not, is bound to play a more important role in our national and individual economy and life, the perpetuation of the concept that Government must be inefficient and corrupt may well be disastrous.

The successful prosecution of the undertakings which our Government is being forced to take over today is vital to all of us. It can hardly be accomplished without faith. Yet the Government can hardly be other than inefficient and corrupt if we assume it must be so. If we believe in democracy, we have no choice but to have confidence in it. It is perhaps important that this be reflected in your legislation. Distrust, as mentioned by Dr. Peters, may prescribe a

timidity in the creation of a National Science Foundation that will assure its ineffectiveness.

Senator CORDON. Just how do we proceed with this panel?

Mr. TEETER. The next gentleman will take it from here.

Dr. ROBERT P. FISCHELIS. I have a brief prepared statement, Mr. Chairman.

TESTIMONY OF DR. ROBERT P. FISCHELIS, SECRETARY, AMERICAN PHARMACEUTICAL ASSOCIATION

Dr. FISCHELIS. Mr. Chairman and members of the committee coordination of research has played a tremendously important part in the accomplishments of the medical profession during the war years. While much of our progress in the treatment and prevention of disease in these years may be traced directly to the stimulus of the war effort, it has been shown rather clearly that cooperative effort and adequate financing of both pure and applied research projects can accelerate progress in this field enormously.

Never in the history of medicine or pharmacy has any drug been introduced to medical practice under such favorable and scientifically controlled auspices as has been the case with penicillin.

In the past, it has been the custom for scientists in the drug industry to maintain a liaison with university laboratories and research foundations engaged in the quest for the cause of various diseases and the search for a remedy based upon the revelation of the cause. The research laboratories of the drug industry have, of course, been engaged to some extent in pure research also, but their greatest contribution to medical science has been to make available in finished dosage form, at a cost which is not prohibitive to the average citizen, the seeming miracles which had their genesis in the test tubes of the scientist working in the university or foundation laboratories. Translating the discovery of insulin for the maintenance of the diabetic into the form in which its daily use has reached a stage of fair convenience at a cost which is not prohibitive to thousands is an achievement of coordinated pure and applied research. Yet, it took many years before all who might benefit from the discovery of insulin received its full benefits.

The introduction of insulin came during more leisurely times. When it was discovered that penicillin had unusual properties for combating infections, we had moved forward considerably from the days of the introduction of insulin. A revised food and drug law had been placed on the statute books. This law has the "new drug" provision which makes it mandatory to obtain the approval of the Food and Drug Administration for the marketing of a new remedy. Machinery was already in motion to determine the safety of the drug. Because the yield of penicillin from known methods of manufacture was limited and the military forces needed all that could be produced, it was important to prevent waste. Hence, the committee on chemotherapeutics and other agents of the Division of Medicine of the National Research Council were charged with the duty of determining the kind of cases in which penicillin might be used for curative or experimental purposes. As the supply of penicillin became more plentiful and allocations were made for the use of civilians, it was this committee which determined the indications,

contra-indications and mode of administration and dosage for penicillin, all of which information was made available to physicians.

Steps were also taken under the powers of the War Production Board to distribute this drug through designated hospitals and in such amounts as were calculated to serve the best interests of the greatest number of patients requiring the drug.

This is but a sketchy outline of what coordinated effort accomplished. On the production side, there was the coordination by the OSRD and the War Production Board in encouraging manufacturers with some experience in the production of biological products or products of fermentation to construct and use the most available facilities for producing penicillin in the largest amounts possible. There was encouragement of research in new methods of production, in methods of speeding production, in methods of testing and packaging, in short there was intense and keen study of every phase of the problem from the selection of the proper strain of mold to the concentration of the finished product into the smallest effective dose for administration. And in this series of procedures, existing Government laboratories, notably the Regional Research Laboratory at Peoria, Ill., the laboratories of the Food and Drug Administration, and the private facilities of a number of university laboratories, as well as the facilities of the laboratories of the drug industry, were used to the fullest extent in solving the hundreds of problems which arose in the effort to produce a safe and potent finished remedy at a cost which the average citizen would eventually be able to afford.

When it is contemplated what was accomplished in this one effort alone over a remarkably short period of time, there can no longer be any question of the advisability of coordinated research in the field of health and medical science.

As to the coordinating procedure, I think it is clear that, since the health of the people is of national concern, the promotion of scientific research fundamental to improvement of the health of the Nation is also a concern of all the people through their Government.

It is also clear that the best progress in this field is made by combining the virtues of a number of incentives. To the scientist working in the laboratories of the universities, the foundations, and the Government, the end sought may be service to humanity and the inner satisfaction of solving what has heretofore been the insoluble. To the scientist in industry, there is an equal satisfaction in making possible the practical application of great scientific discoveries, and to those who sponsor his activities there is the incentive of profit. Modern producers of scientific drug products divert considerable sums from the proceeds of sales of drugs to research. This research takes the form of inquiry into better methods of production, modification of existing products to meet more specific conditions or needs, and also pure research which may lead to nothing of profit to the enterprise.

In the United States we need a coordination of the efforts of all of these groups, and it is my belief that a research foundation, such as is contemplated in the legislation you are considering, can furnish the necessary coordinating factors and stimulate activity in the directions which will be most effective for the national health and welfare.

Senator Cordon. Pardon me, I am going to ask Mr. Teeter to handle the hearing from now on. I'm sorry, but I'm called to the

floor in connection with a call of the calendar, and I must leave. I don't want to adjourn the meeting until you have had the opportunity to complete your statement.

(Mr. Teeter assumed the chair.)

Mr. TEETER. Dr. Fischelis, I do not wish to presume to take the position of a Senator here, and I am somewhat embarrassed by being in this position. However, I would like to suggest that we permit Dr. MacEwen to go on with his discussion, and then perhaps we can have some panel discussion back and forth. May I ask you to continue, Doctor.

TESTIMONY OF DR. EWEN M. MACEWEN, IOWA COLLEGE OF MEDICINE

Dr. EWEN M. MACEWEN. Mr. Chairman, while this statement is my own, I feel it reflects very much the unanimous opinion of the Association of American Medical Colleges, which I represent.

I cannot believe that it is necessary for any one to appear before this body to argue the need for full mobilization of the scientific talent of our Nation. Certainly if such a doubt ever existed in the minds of intelligent persons, the experiences of the past few months should have dispelled them. General Marshall's statement that "a rich nation must be a prepared nation" is still fresh in our memories. A generation or less ago preparedness was expressed in an international armament race. Tomorrow it will be a race for scientific supremacy.

We were fortunate that World War I was primarily one of armament and that the same was true of World War II in the early states, since both found us in the typical American tradition of unpreparedness. In both instances our allies were able to fight a delaying action until we could get ready to fight. In the most recent conflict the margin in our favor was entirely too small for comfort. If we are so unfortunate as to be drawn into a future war, we will not be able to count on any nation's holding our enemies at bay until we get ready. We won because time, and the blunders of a paper hanger gave our scientists an opportunity to develop more accurate and more destructive weapons than our enemies. Next time we will have neither of these; science will strike when ready and perhaps without warning. The only defense against future wars will be scientific and industrial supremacy. Both of these are very dependent upon basic research. We can maintain scientific supremacy if we fully utilize the scientific talent of our country, and supply a sufficient number of adequately trained recruits each year.

For almost two and three quarters centuries, scientific development in America was very slow. We depended largely upon central Europe for scientific development and graining. In the field of medicine this continuous stream of pilgrims continued to flow to the medical meccas of Austria and Germany into the early years of the present century.

During the declining years of the nineteenth century a social revolution occurred in this country in which our youth challenged paternal forcordination and began to develop the American way of free choice and free enterprise. From that day American began to roll and in less than half a century achieved world supremacy in medicine, and parity or supremacy in most of the other fields of science and industry. This despite the fact that neither basic or applied research have been adequately supported at any time, whereas government subsidy fre-

quently supported our competitors. American research, handicapped as it has been for lack of funds, met this challenge primarily because our scientists were unrestricted. They were free to choose their problem and were unhampered in their methods of attack. Our competitors fortunately for us did not have a similar freedom.

Only when a person with an inquiring mind finds a problem that challenges him will the most effective research result. Restricted or assigned research may with the trained mind help meet an emergency but it lacks the stimulus necessary to greatest success in normal times.

What applies to science in general is particularly true in medicine. The medical scientists is constantly confronted by the unknown. Given a prepared mind, time, opportunity, and adequate resources the problem will be solved. But medical research is very expensive. Most of it must be attempts to solve small basic problems that in themselves may appear insignificant, but in the aggregate may result in the cure or control of another disease. For this and many other reasons medical research must be unfettered at all times, and such data as required made available to all. Think what we would have suffered if medical discoveries had been held secret. We are dependent on most of our neighbors for many of our most useful agencies. The terrible toll of typhoid fever in our Army camps of 1898 is not forgotten.

The discoveries of a British Army surgeon made it possible for us to eliminate this scourge from our Army in World War I and almost entirely in our civilian population. As a result of this and other research we were proud in 1919 to announce that only 3 out of every 200 soldiers died from disease. More recently we are indebted to a Canadian scientist for the control of diabetes. Still fresher in your memories are penicillin, DDT, and other agencies received from foreign countries. Today we can boast that only 3 out of every 5,000 inducted into our Army in World War II died from disease. Our civilian population has also as the result of medical research been free of devastating epidemics such as existed at the close of World War I.

Proud as we are of these records we have still a long way to go. Cancer, heart disease, mental conditions are but a few of our unsolved problems that with adequate support will ultimately yield to research. The length of time required to solve these will depend upon how adequately medical research is encouraged and supported.

Mental disease alone confines to institutions an army in size almost equal to the maximum strength of our Army in World War II at an annual cost of $175,000,000. During the past decade medical research has made possible the return to society as normal individuals many thousands who would have been declared incurable less than a generation ago. Dr. Bush has estimated that the need for Federal assistance to medical research will reach its peak in 5 years and level off at about $20,000,000 annually. If by medical research an annual reduction of 12 percent in the cost of mental cases could be made the saving from this alone would be almost $21,000,000 each year. Think what a preventive for the common cold would save in lives and loss of production.

If we are to have a strong Nation we must have a healthy Nation. Adequate medical research is the only key to unsolved health problems. The primary responsibility for this basic and applied research

rests with the colleges of medicine. They alone have the facilities for the application of basic results. Up to the present we have been seriously handicapped by inadequate research funds. Endowments and grants-in-aid from private foundations have been the main source of funds. In recent years the returns from these sources have been declining. Unless a more dependable source is made available medicine, medical research, and the health of the Nation will suffer.

It is recognized that the health of the Nation is the concern of the Government. Congress recognized this when it established the United States Public Health Service. I believe that it is equally a function of the Government to see that every effort is exerted to provide through research every possible agency to combat disease. This can best be done through unrestricted Government aid, administered by a nonpolitical body of competent scientists selected on a broad geographic basis.

I am happy to have this opportunity to add a few words in favor of the bill sponsored by Senator Magnuson because it reflects more nearly my experiences in more than a generation in medical education and because it more nearly reflects the opinions expressed by the representatives of the 22 schools of medicine west of the Mississippi, at a meeting held in Denver last April to consider the question on research submitted by our late President to Dr. Bush. It more nearly meets the opinions:

(1) Because they were unanimous in their desire for the Government to establish an independent agency.

(2) That the powers of the foundation be vested in a nonpolitical board of scientists, selected on the basis of interest and ability in research, and with geographical representation.

(3) That the Director—preferably an executive secretary—be appointed by and subject to the board.

(4) That the terms of the board members be limited assuring new blood and better geographical distribution.

(5) I am opposed to representatives of Government agencies on the board. Instead liaison committees from each of the subdivisions of the foundation and Government agencies concerned should be formed for mutual exchange of ideas.

(6) Its provisions for funds more nearly meet the ideal for medical institutions—grants-in-aid, outright unrestricted grants, scholarships, and fellowships.

I would like to stress especially the scholarships for undergraduates in medicine desiring training in research. This is the area from which our science army must draw its recruits.

The gifted student should be introduced to research and given sound training in the fundamentals of scientific investigation early in his medical training. Graduates lacking this training are not inclined to return to basic research. If scholarships were available many more young men and women would, at the end of their preclinical years, elect to devote one or more years to full-time research, before entering their clinical years. That many students are receptive if opportunities for research are provided is amply proven by recent surveys at a number of medical schools. In a sampling that is statistically significant almost 50 percent requested more research in their undergraduate curriculum. Inoculate these early in their career with the germ of research and many of them will continue in

it upon graduation. There have never been enough fellowships to encourage these young medical graduates to continue in a life of education and research. Today this need is greater and more serious than ever before. For the past 4 years we have had our College of Medicine on a continuous program—a new class admitted every 9 months—and the students graduating in three calendar years. Owing to this war emergency measure there has been no time for young men to devote time to research. In normal times a number of able recruits have been obtained from each graduating class in medicine for education and research. So far we have lost this normal quota from five classes to duty with our troops. Most of these have served near the front line chiefly in emergency work, out of contact with regular medicine from 1 to 3 years. If adequate fellowships are provided many of these will elect to return to research and institutional work on discharge from the Army. None of our medical schools will have sufficient fellowship funds to meet the demands of our graduates. Unless something is done quickly this 5-year void will be permanent and medical research and the health of the next generation will pay for the neglect. The Federal Government has a major responsibility to protect the health of its people. How can it justify a failure to supply fellowships and scholarships for research, needed in the interest of our Nation's welfare?

If we are to mobilize an all-out effort to defeat disease, unrestricted grants are needed for our weaker schools to assist struggling young scientists, and to make it possible for these schools to secure more able teachers by providing necessary research supplies and equipment.

The plan proposed by Senate file 1285 for a national research foundation would adequately meet the needs of all medical schools for additional funds for investigation. Such a foundation should not replace private agencies or foundations but should supplement their effort. Furthermore it should in no way conflict with the research program of other governmental health agencies. Much of the research in the Medical Corps of the Army, Navy, and United States Public Health Service must by the nature of the assignment be restricted and prescribed.

Unrestricted and unprescribed civilian basic research will complement their efforts. All three of these services must depend upon the colleges of medicine for their medical staffs and each service will profit if the recruits are better trained in research.

In more than 30 years of association with medical education I have never known a medical school adequately supplied with research and scholarship funds. Endowments that appeared adequate a generation ago are wholly inadequate today. Costs have increased and earnings from these funds have been reduced. The great foundations no longer have huge earnings from which to draw and some of them are liquidating their principals. Special funds must be begged from industry and from private sources. Our State legislators are deeply tax conscious and under constant pressure from constituents to reduce taxes and costs. Education and research often suffer first cuts.

It is beyond reason to expect the scientist, gifted though he may be and full of ardor for his task to choose as his life's work a career that promises bare sustenance as recompense. The shrinking endowments and gifts must first go to the support of these men. What is left will go to investigation.

If medical research is to be maintained on an adequate level, these sources must be supplemented. Since the health of the Nation depends upon adequate and progressive research it must be the concern of the Government to forward that research.

I therefore urge the acceptance of the Magnuson bill which provides for adequate Government subsidy for the maintenance of a comprehensive research program since it more accurately reflects the opinion of medical educators and scientists.

(Supplementary statement by Dr. Ewen M. MacEwen:)

The executive council of the Association of American Medical Colleges met in Pittsburgh October 27, to 31, where it unanimously approved the recommendations of the Bush report requesting the establishment of a National Research Foundation and unanimously approved the Magnuson bill, S. 1285, as more nearly representing the principles desired in the establishment of this foundation, and requested that these recommendations be brought to the attention of the executive session of the association. This association with 74 of the 77 schools represented, unanimously adopted the above recommendations on October 30, 1945.

(Senator Brooks assumed the chair.)

Senator Brooks. Does that complete your statement, Doctor? Thank you. I'm sorry I was detained, gentlemen, and wasn't able to be here during the entire morning. I wonder, is Dr. Fishbein here? Would you come up, and you other men remain seated with us while we listen to Dr. Fishbein?

Good morning, Doctor. It is getting near the noon hour. Now that I am here, I want to stay with you and do whatever is advisable. I am wondering if you want to read your prepared statement, or file it and then just talk it.

TESTIMONY OF DR. MORRIS FISHBEIN, EDITOR OF THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION

Dr. Morris Fishbein. I will file it, and I can present my main points in about 5 minutes.

Senator Brooks. Then we will have a panel discussion, which I think will be a helpful thing.

Dr. Fishbein. I have filed a statement with the committee. I appear as the appointed representative of the board of trustees of the American Medical Association, and I present also a statement by a joint committee on postwar planning, representing the American College of Surgeons, the American College of Physicians, and the American Medical Association, and several other organizations in the field of medicine.

The great number and diversity of the measures that have been presented have led us to believe, of course, that it is going to be difficult to find a formula, and we have no perfect formula to suggest, for the setting up of a National Science Foundation. We believe there are certain factors that should be avoided, including anything that would incline toward domination of research, toward any inhibition of investigations carried on by private initiative and, we are of course, anxious to avoid spending funds without a reasonable likelihood of a return.

We believe the work carried on during the war by the Office of Scientific Research and Development, and particularly the Committee on Medical Research, is of the greatest importance, and proves funds can be used satisfactorily to encourage research, and particularly to coordinate and intensify the speed with which results are secured, and that is particularly the case in what is commonly called applied research.

The customary lag between the introduction of a new discovery and its general use in medicine has been observed with insulin and penicillin.

Insulin, after many years, is still not used as widely as it might be by numbers of physicians, and the same applies to penicillin, although the lag in the introduction and widespread use of penicillin was unquestionably shortened by the coordinated effort to determine its values and toxicity, as established by the Committee of Medical Research.

Our committee is, in general, in favor of the Bush report, and recognizes the great importance of the five main points mentioned in the Bush report, namely, stability to insure long-range programs, selection of a proper administrative board, promotion of research through contracts or grants to organizations outside the Federal Government, support of basic research in colleges, universities, and research institutes, leaving internal control of policy, personnel, method, and scope to the institutions themselves, responsibility of the organization to the President and the Congress.

We are very doubtful of the desirability of setting up anything like the National Science Service, as mentioned in some of these bills. We believe that the maintenance of the national roster is of the greatest importance, so that there will be at all times a directory of men capable in the field of science, but we rather doubt the necessity for the Government to retain any hold such as would be involved in the setting up of a National Science Service. We believe that the allotment of funds proposed is satisfactory as a beginning, as an experimental basis, but experience will show perhaps that there should be other allocations, and we are rather convinced that these allocations will change from time to time, as many others have already mentioned.

We doubt the desirability of entering at this time into research on the social sciences, and I will mention the chief reason for that, which is thegreat danger of the use of so-called research in the social sciences for political purposes and to influence legislation. We are aware of the various measures that have been introduced into Congress, providing large sums for research in dentistry and in neuropsychiatry, and some $10,000,000 for tuberculosis, both for research and study, and for proposals in the field of cancer, and we believe that Dr. Bush has a comprehensive program developed, so that there would not be constantly individual bills for large sums for individual studies.

The great value of such a foundation as the National Science Foundation is to maintain proper proportions in relationship to various subjects, rather than control by some temporary pressure of public opinion.

Now, medical science, is, of course, closely related to national defense. Medical science is also closely related to the basic sciences. The fellowships and scholarships that are proposed would obviously

come to the field of medicine as well as international defense, and the basic sciences, and we believe it is of the greatest importance to have the five-provision program coordinated in the setting up of a structure, and we believe that that might be developed by having the chairman of each division also a member of the regulating or dominating board of the National Science Foundation. In fact, on examining the various bills that have been proposed, we feel that the directing board should have the authority; the directing board should nominate the director to the President. They might nominate alternates, of course. The directing or administrative board might consist of the five directors of the various divisions, with five other scientists chosen because of their achievements and knowledge in the field of science, and preferably nominated to the President by some such agency as the National Academy of Science or some similar group that would be familiar with leadership in these fields.

We believe that the subsidiary advisory boards that have been mentioned are perhaps just a beginning, and that from time to time there will of course be other advisory boards set up under the main board, but the responsibility for these other boards, for the director and all of the subdirectors could very well rest with the chief administrative board.

We believe that the dissemination of information is of the utmost importance, and there must be free interchange of information between scientists if we are to make the best possible progress; we feel that there is one hazard in the creation of a National Research Foundation, namely, the tendency to monopolize personnel to the extent of depriving private industry, private education and research institutions, and to deprive other nongovernmental agencies from securing workers in a field in which there is always a shortage of competent investigators. It would be unfortunate if the Government became too great a competitor with private education, or public education, and with research institutions and with nongovernmental agencies for the men available in the field.

Now, I have mentioned the general structure of the board, and the manner in which it would be developed. In fact, the idea of coordination of the various divisions might be developed to such an extent that there would always be a representative of national defense, for instance, on the medical board, a representative of basic science on the medical board, a representative of the medical board on the basic sciences, and the national defense, because the great difficulty in these massive organizations is the failure of one division to be familiar with what is going on in the other, and the lack of coordination. The interlocking of membership between the divisions is exceedingly useful. I have seen that done in the council on pharmacy and chemistry of the American Medical Association, the general medical advisory board of the National Foundation for Infantile Paralysis, the special medical advisory board of the American Red Cross, and the Division of Medical Sciences of the National Research Council, in which organizations the various parts interlock and are coordinated through interlocking membership. It is of the greatest importance in securing coordinated and intensified action.

All of us are especially interested in that division of the bill which would increase the opportunity for young men with fellowships and

scholarships, and we are quite certain that in the appointment of fellowships and scholarships there must be clear understanding between the different divisions. Conceivably, the one division that is at the moment popular might again take young men or lead young men into that field of research, rather than into some other. Now, the place of the Federal agencies in this matter has already been mentioned and is referred to in the bills. We have the definite feeling that the directing board might well include 10 men, as has been mentioned, and that all of the Federal agencies, including the Bureau of Medicine and Surgery of the United States Navy, the Medical Corps of the United States Army, the medical research activities of the Air Forces Medical Department, the research functions of the Food and Drug Administration, the Medical Department of the Veterans' Administration, the Medical Department of the Bureau of Maternal and Infant Welfare of the Department of Labor, and indeed many other Federal agencies that are concerned with health should be ex officio members of the subdivision of medical sciences. If the director himself could not attend, obviously he could provide an alternate, because it would be important to have clearly before us the research carried on in governmental agencies as well as those carried on by the National Foundation. It does not appear to be clear whether or not the proposed National Research Foundation is also to make grants to governmental agencies concerned with health and medical research, although parts (b) and (d) of section 2 of S. 1297 do define somewhat these functions.

It is important to know whether or not the National Research Foundation is also to make grants for research to Federal agencies, or whether they would be limited to the budget they have presented to Congress.

Senator Brooks. Would you favor them being limited to the budget provided for them?

Dr. Fishbein. Yes, I would feel definitely the Federal agencies should be confined to the budgets granted by Congress and the appropriations of the National Science Foundation be outside of governmental agencies, and that should be made clear. It is not clear to me in the bill as it now stands.

On the question of patents, I must admit there are so many ramifications and intricacies that I would not want to venture an opinion. I think it would be better if the relationship to patents were entirely avoided and worked out much more carefully on a larger scale in some other measure. I am convinced, from previous experience in this field, that if S. 1297 should be adopted as it now is, leaving to the director the authority to decide whether or not a patent is to be dedicated to the public or is the property of the inventor or, indeed, even to determine the proportions to which such a patent shall be the property of either the Government or the inventor, there would result so much possibility of controversy and dispute as to negative the value of the entire measure, discouraging investigators from association with the National Science Foundation or from maintenance of association with the National Science Foundation.

There are such tremendous interests involved in this field, billions of dollars involved in the ownership of patents in the field of medicine, that controversy over that alone might break down the entire purpose

and intent of the National Science Foundation, and might, in fact, discourage investigators from associating themselves with a National Science Foundation, and obviously the purpose of the measure is to encourage investigators in this work.

I feel very strongly that it is of the utmost importance to encourage international development of science and an international exchange of scientific and technical information. So important is continuous interchange of information regarding disease and measures for the prevention and treatment of disease, that all medical science and scientists urge the establishment of an agency to be concerned with health, the prevention of disease and the problems of medical care under the organization of the United Nations.

In fact, I would say we have already too long delayed the establishment of suitable interchange of information with all the countries of the world on problems of disease.

Now, the provisions under "Miscellaneous" are too restrictive as to materials or equipment purchased by Federal funds or furnished by the Federal Government in connection with research.

Now, as I remember the measure, if an investigator were given a grant, all apparatus purchased would be the property of the Federal Government; he would have to give it back to the Federal Government at the end of the research and return the material to the Government, and you would be building yourself up a vast surplus of unused or discontinued apparatus. Some means must be found for the making of small grants for permanent possession of apparatus by the scientists as a part of the grant made to them. You are going to bring in there a tremendous bookkeeping just for keeping track of small amounts of material purchased, under the law as it is now written. Some means should be found for the suitable disposal of such equipment.

The coordinated and intensified research in the field of health and medicine carried on during the war by the National Research Council in association with governmental agencies has yielded vast benefit to people of the United States and indeed to the people of all the world. By such coordinated and intensified research invaluable time has been saved in extending the uses of penicillin and in promoting its manufacture on a large scale and availability at small cost. The number of lives thus saved is tremendous, indeed incalculable. Similar investigations in the uses of the sulfonamide drugs, in the development of the uses of blood and the various derivatives of blood, investigations in the treatment of burns, in the control of infectious diseases such as malaria and many tropical disorders, in diet and nutrition, have already all gained by application to their problems of well supported, well coordinated and intensified scientific research.

The American Medical Association desires to assure the Congress that it appreciates the vital importance of the legislation proposed and to express the hope that an adequate measure for the support of scientific research may soon be enacted. In general, the arguments that have been presented in the Vannevar Bush report have our full approval. With slender financial support the scientific departments of our colleges, universities, and research institutions have served a great purpose. Federal aid to such institutions may extend their opportunities, provided they are not so greatly controlled in the acceptance of Federal support as to limit their initiative and freedom of action. All scientific authorities are agreed that "research is a

bird that sings only when it is free." Discovery requires the broadest possible liberty to search in as many places as possible, by as many competent scientists as possible, in any manner and by any means that they themselves consider possible. The recommendations of the Bush report indicate how this can be done. Those recommendations may well be followed.

In the structural organization of the proposed National Research Foundation the recommendations of the Magnuson bill, S. 1285, would seem to approach more nearly the type of structure that has been considered suitable, since that structure is more in accord with the type of organization that has been found efficient in institutions that have been carrying on excellent projects for many years.

Senator BROOKS. Thank you Dr. Fishbein. As I said, the hour is getting late, but I think we might have about a 5-minute discussion on each one's part, if you care to discuss it at the present time.

Dr. Butler, do you wish to lead off here?

Dr. BUTLER. I think I would like to make one remark, because I think it is very significant of a trend in public opinion. As I hear Dr. Fishbein, his support of this legislation, I can't help but remember his vehement denunciation of Federal support of medicine and research but a few years ago, and I think what he says today therefore is very important.

Senator BROOKS. Do you have any comments, Dr. Fischelis, to make?

Dr. FISCHELIS. I am at a bit of a disadvantage, because like Dr. Fishbein, I have not had the benefit of the comment of the council of the American Pharmaceutical Association on this. I would like to have the privilege of supplementing my remarks today with a statement that would represent the views of the association. The statement I made today is largely my own views.

Senator BROOKS. I think you can all feel free to submit any supplementary remarks you want for the record.

Doctor, do you have anything further to say?

Dr. MACENEN. Nothing, except that in a week our council will meet, and I would like to present this whole issue before our association meeting at that time.

Dr. SCHIMMEL. Dr. Butler, you say it is odd that those advocating democracy as a form of government to be adopted throughout the world have so little faith in democracy at home, and go on to make the statement that it is important that this be reflected in your legislation, reflecting again to the confidence in democracy. I think I know what you have in mind, but I feel it should be made clearer. Perhaps the other members of the panel would then want to discuss it.

Dr. BUTLER. I thought I could avoid discussion by merely referring to Dr. Peters and the manner in which he dealt with that point, which I thought was very good.

So often the lay individual has a feeling that we must set in all kinds of controls and adopt various means of circumventing authority when we establish a Federal agency, in order to avoid what they conceive of as the inevitable inefficiency of Federal agencies.

I would like to call attention to the fact that we more and more are going to have to deal with Federal agencies, whether we like it or not, and let's see to it that we adopt an attitude which says they are important, they do affect us, we must have the confidence of all

in establishing them in a manner which will make them good, not inefficient, and not in their establishment say, "We must make them inefficient because they are bound to be poor."

Dr. SCHIMMEL. I take it your comment was directed to the original testimony of Harold Smith, the Budget Bureau Director, that proposed that you have a single administrator and an advisory committee, and that was essentially a more democratic form of organization.

Dr. BUTLER. I read Dr. Smith's testimony with interest, but I felt I was totally incompetent to render any judgment as to which type of governing organization was preferable.

I think I would only like to make one comment, because it seems to me that it clarifies the issue a little bit—perhaps the argument is not very important. If you have a director who is appointed by the board, such a board as is visualized here, he is going to be the fellow that runs the board, and I can't see, therefore, a great deal of difference in having the director the responsible individual appointed by the President, and in having the director the individual appointed by the board, in terms of the importance of that administrative or executive individual.

Dr. FISHBEIN. Mr. Chairman, I merely would point out that in some Government agencies the director has on occasion changed the board whenever the board recommended in opposition to the suggestion of the director. That has happened in the past in our Government, and for that reason, most scientists are convinced that it would be desirable that the board of directors nominate the executive secretary to the President.

Senator BROOKS. For stability, is that What you mean?

Dr. FISHBEIN. In that way, a director who was not getting along very well with the board could then remove the board, rather than have them remove the director.

Senator BROOKS. Any further comment? If not, I think we will adjourn until tomorrow morning at 10 o'clock, in the same place.

(The hearing adjourned at 1:10 p. m.)

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HEARINGS ON SCIENCE LEGISLATION
S. 1297 and Related Bills

TUESDAY, OCTOBER 23, 1945

UNITED STATES SENATE,
COMMITTEE ON MILITARY AFFAIRS,
SUBCOMMITTEE ON WAR MOBILIZATION,
Washington, D. C.

The subcommittee met at 10:15 a. m. pursuant to adjournment on October 22, 1945, in room 457, Senate Office Building, Senator James M. Mead, New York, presiding.

Present: Senator James M. Mead, New York.

Also present: Dr. Herbert Schimmel, chief investigator; Mr. John H. Teeter, director of hearings for Senator Magnuson.

Senator MEAD. The committee session will be in order and the first witness will be Dr. Homer Smith, New York University College of Medicine.

Let me make an announcement. In view of the fact that the President will be before Congress at noon today, we will have to adjourn this meeting rather promptly, and, therefore, it would be appropriate if we could get these messages into the record promptly, in order that we might hear all the witnesses scheduled to be heard this morning.

Dr. Smith, you may proceed.

TESTIMONY OF DR. HOMER W. SMITH, PROFESSOR OF PHYSIOLOGY, NEW YORK UNIVERSITY COLLEGE OF MEDICINE

Dr. SMITH. Mr. Mead, you are familiar, at least in general outline, with the remarkable achievements of medical science during the recent war, but I would invite you to look back over a few centuries in order to gain a greater perspective.

The Black Death, which repeatedly swept across Europe in the fourteenth, fifteenth, and sixteenth centuries, in its first wave alone killed approximately one-quarter of the entire population of the Continent, and in some areas three-quarters of the population. Although the most devastating plague in history, this is only one of many waves of death that have recurrently swept the world. Bubonic plague, smallpox, yellow fever, Asiatic cholera, and many lesser pestilences have until recently wreaked unbelievable devastation. Most of these pestilences have been brought under control in Europe and America, but not all of them: the well-remembered influenza epidemic of 1918–19 affected not less than 200,000,000, and possibly 700,000,000 persons, and was one of the 3 greatest plagues known to history. The number of deaths over the world has been conserva-

tively estimated at 6,000,000 to 10,000,000. These figures are perhaps large enough to be still worthy of mention in these august Halls.

When the world is sick or at war it wants the doctor; when it is well and occupied with other things, the doctor may be neglected. However, as matters of peacetime importance, may I call your attention to the fact that the life expectancy among the American people increased from 35 years in 1800, to 49 years in 1900, and to 65 years in 1942. This increase in the expectation of life is attributable largely to a reduction in infant mortality, since for every three children who die under current conditions, more than seven died two decades ago. But advances have also been made in the prevention or therapy of diseases affecting adults. A century ago a hospital was only a place where the poor were sent to die. Today the large majority of persons admitted to hospitals are restored to health, and a still larger number, even without their knowledge, are protected from disease. It has perhaps not been sufficiently emphasized that in addition to the great modern life-saving achievements of surgery, the sulfa drugs, penicillin, and blood plasma, every man, woman, and child has in some measure been freed of disability and pain. Life has been made not only safer, but happier throughout the whole of its 65 years.

Much of this progress in medicine is attributable to accidental discovery, but a large part of it, the larger part, is attributable to the development of the so-called medical sciences, a group of sciences which deal with living organisms of all kinds, with their growth, nutrition, and reactions, and with the infinitely detailed physical and chemical nature of their vital processes. It is a matter of high probability that further progress, for example in the treatment of diseases of the heart, blood vessels, and kidneys, of cancer, or in the avoidance of senility, will come as the result of explorations in medical sciences seemingly quite unrelated to these specific problems.

I have enlarged upon this point in order to emphasize that the future progress of medicine requires that the entire field of medical sciences be developed impartially. A broad policy of nurturing basic science does not, of course, exclude the coordinated effort to use existing knowledge and weapons in the most effective manner. Both methods of attack should be used, but fundamental science must be nurtured at all costs.

That Federal aid is needed, if existing facilities and personnel for medical research are to be utilized in the most efficient manner, and if new personnel are to be trained and paid, has been emphasized by others.

The problem is how best can Federal aid be utilized. Early this year a committee of nine persons, under the chairmanship of Dr. Walter W. Palmer, made a careful study at Dr. Bush's request of the needs and possible mechanisms of extending Federal aid to medical research. In addition to Dr. Palmer, who is professor of medicine at Columbia University and director of the medical service of Presbyterian Hospital in New York, the committee consisted of—

Dr. William B. Castle, professor of medicine, Harvard University; associate director, Thorndike Memorial Laboratory, Boston City Hospital.

Dr. Edward A. Doisy, director, department of physiology and biochemistry, St. Louis University School of Medicine (recipient of Nobel Award).

Dr. Ernest Goodpasture, professor of pathology, School of Medicine, Vanderbilt University.

Dr. Alton Ochsner, professor of surgery and head of department of surgery, Tulane University School of Medicine.
Dr. Linus Pauling, head of the division of chemistry and chemical engineering, director of the chemical laboratories at the California Institute of Technology.
Dr. Kenneth B. Turner, assistant professor of medicine, Columbia University.
Dr. James J. Waring, professor of medicine, University of Colorado School of Medicine.

It is appropriate for me to reemphasize certain important points made in this committee's report, and in preparing this statement I have consulted with all who served upon the committee. The views expressed here may be taken as having their unanimous endorsement. The committee proceeded to its task by consulting as many persons as time permitted. By group meetings in various regions, the deans and representatives of 73 out of the 77 medical schools in the country were interviewed. Investigators in all fields were consulted, as well as experienced administrators, industrialists, and heads of foundations, and many who could not be seen in person were engaged by correspondence.

At the conclusion of its inquiry, the Palmer committee felt that because of the special problems faced by medicine, Federal aid to medical research could best be administered by an independent, autonomous commission, and it so recommended to Dr. Bush. However, in view of the recommendations returned to Dr. Bush by those who were studying the question of Federal aid to the natural sciences and a scholarship program, and, recognizing the administrative difficulties of an independent agency, the committee subsequently assented to a program in which medicine would be one division of a broader science plan. This assent was given, however, with emphasis that in this amalgamation the specific principles stressed in the committee's report would in no way be abandoned.

Those interested in medical research are concerned not only with the details of administration, but also with the over-all organization of a National Research Foundation.

The top authority in this foundation, in the opinion of the committee, should consist of a commission or board, some of whom should be laymen, and all of whom should be selected on the basis of their interest and capacity to promote the purposes of the foundation and their willingness and ability to work. The performance of an advisory board tends to become perfunctory, and membership in such a board tends to become merely honorary and empty of the all-important element of responsibility. With a perfunctory and honorary board, a director with power would soon make all the decisions.

This board should be responsible for the appointment and supervision of the executive secretary or director, or as he more properly should be called an executive officer, who will look after the administrative details, but who will not be in a position to dictate or interfere with the functions either of the board itself or of the professional committees appointed by the board.

The top authority should contain no ex officio members. Various Government departments would have varying degrees of interest in the foundation and a representative board would not yield equally interested individuals. The service of ex officio members will inevitably be conditioned, if not severely biased, by the administrative duties and the special interests of their departments, and it cannot

be expected that they would invariably place the broad purposes of the foundation first. It must be recognized that this will be a new Government agency, and there is no more reason for existing Government departments to participate in its control than there is for the foundation to participate in the control of existing Government departments.

More importantly, it should be emphasized that the proposed foundation represents the largest invasion in history of peacetime government into our intellectual life. It will be intimately concerned with our educational and independent research institutions, which are maintained either by private endowment or by State funds. It will influence the selection and education of thousands of young scientists; it must wend its way through many complex problems involving private initiative, and private and foundation capital, State appropriations, private and public schools, and private industry. Its authority should therefore reside in an exclusively civilian and public commission or board, selected as I have said, for their interest and capacity to promote the purposes of the foundation, and for their willingness and ability to work.

It is clearly recognized that adequate machinery must be set up to promote liaison between the foundation and interested Government departments, as well as with all other scientific bodies. In order that Government departments may keep well informed on the over-all policies of the foundation and may always be available for consultation, they should be urged to assign representatives to sit as liaison officers, but without the power of vote.

This foundation should not be charged with the responsibility of reviewing and recommending to the President on matters of scientific policy in existing Government departments. Where the power of recommendation goes, action follows, and such a proposal amounts in effect, whatever its good intentions, to vesting control of scientific work in all Government departments in one body. It is in the best interests of science that all investigators be allowed maximal latitude and be protected to the maximal extent from the danger of limitation and control by any one body.

Passing now to the division of medicine, the responsible members should be persons chosen by the board on the basis of scientific achievement and leadership, wide knowledge of medical problems, and capacity for administration and organization, nominated through the National Academy of Sciences. They should serve on a part-time basis for a term restricted by law to not more than 5 years, and they should not be eligible for reappointment. One of the reasons for a limited term and for excluding reappointment is that service on such a board has tremendous educational possibilities and this educational opportunity should be distributed as widely as possible.

These provisions will also insure as wide geographical representation as is possible, compatible with experience and sound administration. Wide geographical representation is important to insure the interests of science throughout the country, and also to insure equal opportunities for leadership.

It is deemed unwise to install in the division of science ex officio officers or designees from the Army, Navy, Public Health Service, or other Government departments for the explicit reasons stated above in connection with the top organization. Because the problems to be

handled relate primarily to research in nongovernmental institutions, even a minority vote on the part of ex officio members with operating responsibilities carries the potentiality of bias and impairment of this research effort. It is recommended as an alternative that an advisory council in medicine be created, consisting of representatives of the Public Health Service and perhaps other governmental services, with whom the members of the division of medicine may consult on problems of mutual interest.

Senator MEAD. Right there, Professor, I imagine you have in mind the Surgeon General of the Army and the Surgeon General of the Navy, and perhaps some other governmental agencies?

Dr. SMITH. Public Health Service.

Senator MEAD. Public Health Service.

Dr. SMITH. In addition Dr. Fishbein yesterday mentioned a number of major and subsidiary Government activities that have intense interest in medical research. At the time when Dr. Fishbein made his remarks, he did not point out that he was recommending that these persons should sit with the division without the power of vote, but he assured me that was the case after the meeting was over.

The members of the division of medicine, and of other divisions, and their respective technical staffs must be drawn from the already overburdened universities and research institutions, and they will possibly have to give from one-third to one-half of their time to the foundation. Service in the foundation will mean an increased load of labor upon the participants, and a decrease in service to their parent institutions. Moreover, many competent investigators in medicine and surgery draw a small fraction of their income as salary, being dependent financially upon their practice. Participation in the foundation may interrupt this practice and the resulting loss of income may exclude desired persons from service. It surely is bad economy for Government to expect to get its work done by borrowed personnel. The foundation should be authorized to pay the institution or the individual such fees for part-time service as may be required to obtain any man whose help is wanted. The question of adjustment of salary from parent institutions should be left to the parties concerned.

With regard to mechanisms for aid, it is the committee's opinion that unrestricted grants intended to be used as general research funds, and with no portion earmarked for specific purposes, will be the most valuable and productive form in which Government support can be given. The problem of promoting exploration in diverse scientific fields, the stimulation of the activities and intellectual attitudes necessary for discovery, cannot be solved solely by grants-in-aid given for specific purposes. Methods of research are highly diversified; a promising lead may prove patently false within a month and it is just as important that work along that line should be stopped and personnel and equipment promptly diverted to more promising leads, as it is that the first lead should have been explored in the beginning; a technician may be useful this month on one problem, more useful next month on another; a new idea, alien to a preconceived program, may be born after that program is initiated. If a central agency were to attempt to meet item by item the many requirements of research by means of specific grants, the cost in time and labor for administration, both in the foundation and in institutions, would be prohibitive.

Such grants would not only eliminate costly overhead and create a flexible mechanism to meet rapidly varying needs, but they would also promote decentralization; they would allow full play to the wisdom and experience of medical school faculties and administrators whose knowledge in aggregate, and whose particular knowledge of local needs, must always exceed that of a central agency; they would promote research in laboratories where it is now poorly developed; they would foster investigations of an exploratory nature; in short, they would provide on the whole the greatest and most effective stimulus to medical research.

One specific use for such unrestricted grants would be to provide junior fellowships to allow selected medical students to interrupt their course, usually between the preclinical and clinical years, and to devote themselves to full-time research for a year or two. The chances in this country for medical students to gain research experience prior to graduation are rare indeed, and as a result much research ability goes undiscovered. The foundation would have to rely entirely upon the judgment of local research boards for the selection of promising candidates and hence it would be logical and economical to provide these junior fellowships from unrestricted research grants.

In addition, Federal funds should be used to support senior fellowships to enable selected men to obtain advanced training in research, to learn techniques in fields other than those of their basic scientific education, or to begin research careers.

Lastly, important research projects of clear definition should receive special grants-in-aid.

In summary, then, the function of this foundation should be to increase our fundamental knowledge and widen our horizons, and to increase the number of trained investigators who will add basic contributions or share in the coordinated attack on specific diseases.

It is important, now, to look briefly at the possible dangers entailed in this program. Government funds should be administered in such a manner as to encourage rather than discourage the flow of private and State funds into our medical schools and research institutions. As Senator Pepper has said, "Government cannot, and must not, take the place of philanthropy and industry in the sponsorship of research." Much wisdom is here required if our private and State institutions are not to be rendered dependent.

Any effort to accelerate discovery, unless wisely administered, may encourage men to undertake research who are inadequately prepared or unfitted for the task. No one wants spurious research work in any branch of science, and it should be guarded against by constantly encouraging parallel and confirmatory work. Science must strive not to maintain her accepted standards but to raise them.

Neither the top authority of the foundation nor the division of medicine should give prizes, dispense praise or blame, or authorize opinions on scientific questions. The entire foundation should avoid the semblance of scientific authority. What is acceptable or unacceptable in medicine must be established by tested methods of examination and appraisal, and not be made to appear as such because of the imprimatur of a quasi-authoritative body.

We do not regard ourselves as qualified to talk about patents. We understand that this subject, formerly assigned to the National Patent Planning Commission, has now been placed in the hands of a

committee headed by the Secretary of Commerce. We think that it should be left in those hands—that partial or complete solution of this important, complex problem should not be anticipated in legislation providing for a National Research Foundation.

It was suggested in the President's recent message that the proposed National Research Foundation should take in the social sciences. With all respect, we think it would be a mistake to give the new agency any such responsibility. Both the Kilgore-Johnson-Pepper and Magnuson bills are based on the premise that there is a continuing emergency which warrants Federal support for scientific research and education. This new program should be planned and carried out by men and women familiar with the subject; their interest and attention should not be diverted by requiring them to look after research and education.

Indeed, the presence of the social sciences in the legislation would give rise to problems and difficulties which, in our opinion, would greatly prejudice the foundation. Looking only at the scholarship and fellowship program, it is believed that a fellowship board could do an excellent job in the selection and support of scientific students; it would be faced with a very different sort of task, a task for which it would not be well qualified, if it were required to make comparable provision for students of political science, economics, sociology, law, and so forth—in fact, every subject not comprehended by the natural sciences or the humanities.

Lastly, freedom of inquiry must be safeguarded to the utmost. For long centuries science has fought all would-be dictators—superstition, ignorance, prejudice, religion, bureaucracy, autocracy, ambition, greed, and recently fascism. It may truly be said that all that we cherish in our culture has been acquired in consequence of this successful battle. Now science has reason to fear that freedom of inquiry, the right of every man to explore the universe in his own way, may be forfeited to a national policy in which young men and women, moved by the pressures of financial needs, advancement, security, opportunity, and so forth, will be deflected from independent development and drawn to the powerful foci created by Federal dollars; and that utility, rather than the discovery of truth for its own sake, will become a national goal. Did this happen the United States would turn toward a new Dark Age dominated by technocracy, its scientists would be turned into scientific ants, and countries which offer haven and support to intellectual rebels would lead the way to better things. We should not, as a national policy, use dollars to force scientists to devote themselves to imposed intellectual interests. The preservation of intellectual and scientific freedom against the danger of economic bondage is a "fifth freedom" to which we must dedicate ourselves. This can be achieved only if the scientist who does not want to participate in an organized program is aided along with him who does. Here is the last and most powerful argument in favor of a National Research Foundation in which the responsibilities for policy-making devolve directly on a commission or board, and through the board, on the subsidiary scientific divisions.

Failure to recognize that competency, interest, responsibility, and sincerity of purpose must permeate the foundation from top to bottom, that they must transcend all other considerations, can do science more harm than good. To neglect them is to court national scientific

disaster. It is a question, then, of how these desiderata can be attained.

When the Palmer committee was in consultation with scientists throughout the country, the details of a National Research Foundation could not be clearly visualized. Now, wishing to obtain the opinion of our consultants on these details, on behalf of the committee I have polled those with whom we consulted or had correspondence, for an expression of opinion. All these persons had been sent copies of the Kilgore-Johnson-Pepper bill and of the Magnuson bill in advance, without comment. In order to obtain answers expeditiously and without prejudice, a tabulation was prepared, based upon the proposals in the two bills, as presented in the subcommittee print prepared in August by Senator Kilgore's staff. I would be pleased to have a copy of this tabulation and of the covering letter accepted for the record.

Dr. SCHIMMEL. Do you have that here?

Dr. SMITH. Yes, sir.

(The tabulation and the letter referred to follow:)

NEW YORK UNIVERSITY COLLEGE OF MEDICINE,
DEPARTMENT OF PHYSIOLOGY,
New York 16, N. Y., October 2, 1945.

Memorandum from Homer W. Smith.

Subject: Pending science legislation.

Since my memorandum of September 21, I have been requested by Senator Magnuson to testify in the joint Senate committee hearings on the five bills mentioned in that memorandum.

The two bills of major importance are, of course, the Magnuson bill and the Kilgore-Johnson-Pepper bill. These hearings have been postponed until the week of October 29, in order to permit Senator Pepper, who is extremely interested in the medical aspects of this legislation, to return from Europe.

I expect to present the views entertained by those who served on Dr. Bush's Medical Advisory Committee, and to reaffirm certain important points which were made in that committee's report to Dr. Bush. In addition, the members of that committee have proposed that this memorandum be circulated to our consultants, with the enclosed tabulation of the major points involved in the legislation, and with the request that you express your preference with respect to various points in the two bills named above and, if you desire, give reasons for this preference. If this tabulation is returned to me promptly in the enclosed envelope, the results will be organized with the aid of the other members of the committee and presented as an integral part of my testimony.

Care will be taken to dissociate the information obtained in this informal poll from opinions which have been endorsed only by members of the Medical Advisory Committee.

Where formal resolutions from groups of scientists or other persons concerned are available, one copy should be sent to Senator Warren G. Magnuson, chairman, subcommittee of the Senate Commerce Committee, Senate Office Building, Washington, D. C., and one copy to Senator H. M. Kilgore, chairman, subcommittee of the Senate Military Affairs Committee, Senate Office Building, Washington, D. C. One copy should also be sent to Mr. John Teeter, 1530 P Street NW., Washington 25, D. C., who is acting in an executive capacity for Senator Magnuson in organizing the congressional hearings.

Will you please express on the attached sheets by means of a check mark your preference as between the Magnuson bill and the Kilgore-Johnson-Pepper bill with respect to the details here indicated. If you have a preference for either bill without qualification it may be indicated in item 20.

If you feel that it is necessary to give reasons for your vote on individual points, please complete the ballot as far as possible and return it anyway, placing your comments upon a separate sheet.

Please return at your earliest convenience. Time is short. The hearings on the medical sections of the bills are scheduled for October 29 and 30.

Comparison of scientific research bills S. 1285 (Magnuson) and S. 1297 (Kilgore-Johnson-Pepper) before the United States Senate

[Number of ballots returned through Oct. 20, 1945—295]

	Vote for 1	
	Magnuson	Kilgore
A. Agency:		
Name:		
1. Magnuson: National Research Foundation	218	
Kilgore: National Science Foundation		24
Top authority:		
2. Magnuson: Powers vested in board of 9 members (no compensation) appointed by President	258	
Kilgore: Powers vested in director ($15,000 a year) appointed by President		15
3. Magnuson: Board selected on basis of demonstrated capacity to promote interests of foundation and not an ex officio basis	270	
Kilgore: Board includes 8 Government officials (or designees) serving on ex officio basis and 8 public members appointed by President		10
B. Coordination:		
4. Magnuson: Directs foundation to promote a national policy for scientific research and scientific education	260	
Kilgore: Directs foundation to survey and study all Government-financed research and development activities, and to send to President and to the agencies concerned recommendations for such changes as appear desirable		12
C. Military research:		
5. Magnuson: Sets up division of national defense, with advisory committee appointed by board, except that 1 member shall be appointed by Secretary of War, and 1 member by Secretary of Navy	14	
Kilgore: Sets up research committee for national defense, with chairman appointed by President, 3 members by Secretary of War, 3 members by Secretary of Navy, and 3 members by director of foundation. Committee approves all military research contracts		(1)
D. Medical research:		
Name:		
6. Magnuson: Division of medical research	239	
Kilgore: Research committee for health and medical sciences		24
Composition:		
7. Magnuson: Advisory committee appointed by board	272	
Kilgore: Chairman ($12,000 a year) appointed by President, 6 members by the director, and 3 members by head of Federal Security Agency		8
Functions:		
8. Magnuson: To carry out programs relating to research in biological science, including medicine and the related sciences	246	
Kilgore: To advise director with respect to formulation of over-all research and development programs in the fields of health and medicine and to approve specific projects and selection of specific facilities		26
E. Other research:		
9. Magnuson: Sets up, in addition to above, divisions of physical sciences, scientific personnel and education, and publications and scientific collaboration. Authorizes board to approve from time to time such additional divisions as are necessary to permit any arrangement required to support basic scientific research and development for national welfare	13	
Kilgore: Authorizes foundation to promote any research that is in the national interest including, in addition to above, research in basic sciences natural resources, methods and processes beneficial small business and peacetime uses for wartime facilities. Authorizes director to set up such advisory research committees as may be needed		(1)
F. Research facilities:		
10. Magnuson: Authorizes foundation to support scientific research through contracts, grants, or other forms of assistance	281	
Kilgore: All research to be done under contract only		1
11. Magnuson: Does not specify type of institution	236	
Kilgore: Directs foundation to use existing facilities of Federal, State, and local governments, in addition to education and research institutions and private industrial organizations		38
12. Magnuson: Does not specify proportion of funds to be devoted to the work of any division	213	
Kilgore: Specifies that not less than 20 per centum shall be expended for research and development in each of the following fields: (1) national defense and security, (2) health and medicine. Also specifies that of the total funds appropriated, not less than 50 per centum shall be expended in nonprofit educational institutions and research institutions		63

(1) Vote not required.

Comparison of scientific research bills S. 1285 (Magnuson) and S. 1297 (Kilgore-Johnson-Pepper) before the United States Senate—Continued

	Vote for 1	
	Magnuson	Kilgore
G. Research findings:		
13. Magnuson: Sets up division of publications and scientific collaboration and authorizes foundation to publish and disseminate information of scientific value, consistent with requirement of national security	216	
Kilgore: Directs foundation to make available to the public full data on all significant findings. Also, by means of publications, abstracts, library services and the like, to promote a widespread distribution of information useful in research. Authorizes defense committee to classify information when necessary for national security		43
14. Magnuson: The foundation, like other governmental agencies, is left with full power to negotiate such patent arrangements with research contractors as particular situations may require in the public interest	222	
Kilgore: Stipulates all inventions and discoveries resulting from Government financed research are to become property of the United States and to be generally available through royalty-free nonexelusive licenses		52
H. Scholarships:		
15. Magnuson: Sets up division of scientific personnel and education to grant scholarships and fellowships in the mathematical, physical, and biological sciences	246	
Kilgore: Authorizes foundation to grant renewable 1-year fellowships and scholarships for study at nonprofit institutions		22
16. Magnuson: Persons receiving such scholarships and fellowships to be enrolled in a national science reserve and available for call by the Government for scientific and technical work in times of national emergency	213	
Kilgore: No comparable provision		55
I. Annual appropriations:		
17. Magnuson: Authorizes such sums as may be necessary. Unobligated appropriations to remain available 4 years following expiration of fiscal year in which appropriated	240	
Kilgore: Authorizes such sums as may be necessary		27
Compensation:		
18. Both bills visualize that top board will give their (part-time) services gratuitously, except for per diem while in travel status. Do you approve or disapprove the principle that members of the top board should be remunerated for their services?		
Approve	179	
Disapprove	95	
19. Magnuson: Specifies that civilian division members shall be compensated at the rate of $50 a day while engaged in the business of the foundation		
Kilgore: The present bill is ambiguously worded on this point (see sec. 402, sentence 1 and sentence 3). Do you approve or disapprove of the members of the division of medicine or the research committee for health and medical sciences being compensated while engaged in the business of the foundation?		
Approve	232	
Disapprove	37	
20. In general, I favor the following bill (answer optional)	226	2

Signature_____
Position_____

Ninety-five percent of the 295 votes cast are in favor of a board of nine members appointed by the President, as provided in the Magnuson bill. Ninety-seven percent prefer that this board contain no ex officio members, again as provided by the Magnuson bill. Ninety-five percent prefer the Magnuson instruction that the foundation "promote a national policy for scientific research and scientific education" to the original Kilgore provision that it survey and study all Government-financed research and development, and send to the President and the agencies concerned recommendations on these matters.

Ninety-seven percent prefer that the members of the Division of Medicine be appointed by the board, as in the Magnuson bill, rather than by a director. And 90 percent prefer the name Division of Medical Research, as used in the Magnuson bill, to Research Committee for Health and the Medical Sciences, and also the name, National Research Foundation.

On the matter of patents and on six other points of comparison between the two bills, the Magnuson bill is favored by 76 to 92 percent of the votes.

In answer to questions 18 and 19, concerning the principle of remuneration for time spent in the services of the foundation by members of the top board and the divisions, respectively, 65 percent favor remuneration for the top board and 86 percent favor remuneration for division members.

Of 228 persons who answered question 20, which calls for an expression of preference between the Kilgore and Magnuson bills as a whole, and which was marked optional, 226 voted for the Magnuson bill.

Ninety-nine percent of these ballots were signed, giving the person's official position, as requested.

Dr. SCHIMMEL. Dr. Smith, may I ask you a question? Have you ever conducted polls before?

Dr. SMITH. I think I may say yes to that.

Dr. SCHIMMEL. Are you familiar with the techniques developed by Gallup, and others, although not always adhered to by them, for assuring that a poll is objective?

Dr. SMITH. I don't understand your word "objective". In this case the poll would have significance only when the ballot is cast by an informed person.

Dr. SCHIMMEL. The method involves what are known as leading questions. There is a scientific technique developed to make sure the polling is accurate and objective. Are you familiar with that technique? Have you studied it?

Dr. SMITH. Not as a technique, but, in order to avoid that possible error, we utilized almost exactly the comparison of points which is made in the joint print which I mentioned, which was drawn by your staff.

Dr. SCHIMMEL. The reason I asked that is I understand you did that. I know you did that, but, for example, I have at various times studied the technique, and although I don't claim to be an authority on it at all, it seems to me there is one basic error in the whole poll that would be obvious to anyone who made a study of scientific polls.

There are two key words, Magnuson and Kilgore, throughout the questions, which virtually invalidates each individual question, because the people will then bring to each individual question a certain background of discussion that, for example, the Bush committee may have had on these various problems. I am just indicating that from the viewpoint of the scientific technique of polling, the use of any sort of key which would be common to all questions would automatically make such a poll unobjective and unscientific.

I just wondered whether you studied these techniques, because the presence of a key word in each question would be sufficient automatically to bar it from being an objective question.

Dr. SMITH. Dr. Schimmel, there is no prejudice in this country against a bill because it carries a name. Men have given sincere thought to the fundamental principles involved and the ballot itself indicates they have supported it. Frequently they voted for the Kilgore proposal and frequently for Magnuson. The two bills represent different approaches to a problem, and the ballot cast, therefore, I contend, remains completely objective in terms of the principles and it is not influenced by the fact they have been drawn and carry the names of their respective proponents, which serves not only as a convenient method of reference, but serves to give focus to the points of view.

Dr. SCHIMMEL. I just wanted to point out to you that names or key symbols should not generally be attached to the alternative answers to a question. I am not discussing at this point the prejudice or lack of prejudice or influence or anything of that kind, but as an objective

technique of sampling or polling, I understand one should never attach a key symbol to the two alternative answers, because then one can't expect, no matter how unprejudiced the people one is dealing with, an objective treatment of the question.

Dr. SMITH. I think I fully understand the point, but I contend——

Dr. SCHIMMEL. You contend this was an unusual poll, and because we were dealing with scientists we didn't need scientific methods?

Dr. SMITH. A principle is not prejudiced necessarily because it is associated with a proper name.

Senator MEAD. You may proceed, Doctor, because the time is fleeting.

Dr. SMITH. This overwhelming vote in favor of the detailed provisions of the Magnuson bill, and in favor of the bill as a whole, is perhaps not surprising, since the Magnuson bill was drawn to fulfill the requirements of the Bush report, which was itself prepared only after consultation with many scientists. But for this reason this ballot acquires increased significance and force. In matters such as this opinions should be weighed and not counted. The list of persons from whom this poll was obtained was compiled last February before the present legislative proposals were framed. The list was prepared by detached, disinterested parties with the intent of obtaining as representative a sample as possible of medical scientific opinion. Of the replies received, 37 percent were from investigators of professorial rank, 33 percent from men in clinical medicine or surgery, 24 percent from deans or administrators of research institutions, and 6 percent from research workers in such institutes or in industry. They constitute a representative sample of the men who have done and are doing our medical research, and who have brought American medicine into a position of world leadership.

This overwhelming vote in favor of the Magnuson bill shows that these men do not want a one-man dictatorship of science, and they do not want Government domination. They do want an opportunity to promote medical science in the way in which, in the light of their honest convictions, they believe that this science can best be promoted.

In his request to Dr. Bush, the late President Roosevelt asked:

> With particular reference to the war of science against disease, what can be done now to organize a program for continuing in the future the work which has been done in medicine and related sciences?

The Magnuson bill appears to be a satisfactory answer to that question.

Senator MEAD. That was a very interesting statement, Doctor, and I commend you for it and for the work that you have done in connection with the arguments presented. I know it will be very useful to the committee and a valuable addition to our record, and we appreciate your presence here this morning.

And now, we want to move on with the next witness, Vice Adm. Ross T McIntire, Surgeon General of the Navy Department. Admiral McIntire.

TESTIMONY OF VICE ADM. ROSS T. McINTIRE, SURGEON GENERAL, NAVY DEPARTMENT

Admiral MCINTIRE. Mr. Chairman, in the effort to save time, I will be extremely brief in what I have to say. I have a very short

statement that I believe I can contract, and I would like to read a very small portion of it and then expand one or two points. In fact, I would like to stick to the broad aspects of this problem, not getting into details in any extent. I think that will be covered by others.

Senator MEAD. All right, Admiral, you may proceed.

Admiral MCINTIRE. The Medical Department of the Navy is greatly interested in any legislation which is directed toward the improvement of the national health.

Civilian and military medicine vary only in fields of application. They are mutually supplementary and often complementary, for the health and strength of the Navy is directly dependent upon the health of its civilian inductees.

The health of the populace in areas in which it operates is of great interest to the Navy and, the Navy by its own controlled health measures and training, tends to improve the general health of the Nation.

Any program that tends to improve the public health immediately invites the attention of the Medical Department of the Navy. Research considered in its broadest term is probably the greatest single responsibility that this Nation faces today. We have only to look over the history of the past 5 years to see what happens to a nation when a well-integrated plan of research has been neglected. That was the state in which our Nation found itself in 1940.

Planning in research is just as important as planning in any of the fields of economics, or in military preparations. Specifically, the Medical Department of the Navy holds the opinion that the Government service should be closely linked with research programs of civilian nature. There will be a definite advantage to both parties. Such cooperation, collaboration, and liaison between civilian and service agencies is completely essential to any broad health program.

It is my firm belief that in any research board the governmental service should have adequate representation. There is no question in my mind but that such a board should be set up and be considered the top authority in research. This board should be appointed by the President. The function of the directors of this board should be to promulgate and promote a national policy for scientific research and scientific education, and act in advisory capacity in all matters pertaining thereto.

There should be a director of all research and he should also be appointed by the President. He would be specifically directed to carry out the policy as laid down by the board. Mr. Chairman——

Senator MEAD. You believe that the top authority should be appointed by the President, Admiral, but what about confirmation by the Senate? Have you gone into that?

Admiral MCINTIRE. I hadn't carried it that far, but I believe that should be. I think it would be a very splendid thing, for I think this board must be of the highest possible caliber. These men should be selected from the citizens who have a broad view. Scientists should certainly be included and would undoubtedly predominate the board, but this, in my mind, Mr. Chairman, should be a policy-making board, and when I say policy I mean to lay down in broad and sound terms a research policy in all lines.

Then, this board would act in an advisory capacity on the lines that they have laid. Why I have said I believe a director should not be

appointed by the board is for the reason of freedom of action of the director.

The board, however, acting in its advisory capacity, would always be in the position to recommend to the President that the director be changed when he failed to carry out the policies as laid down by the board. Moreover, research, as I see it, will be big business, and sound management will be necessary if any research program is to be successfully carried out.

And so, again, the director should be a man of high quality, of ability to carry out the program as laid down by the board, and of ability to set up the kind of management that would make it successful.

Senator MEAD. As I understand it, Admiral, you don't recommend any specific term for the director?

Admiral MCINTIRE. No. I have no quarrel at all with the terms as laid down in the bills as are presented here. I think that is all right. I think that has been well done. What I am looking at is the topside levels of this organization, the ability to put the board in a completely top-level position, but have the director free to act. He must be given every responsibility to discharge the program.

Then, as you go down through the other levels, I think the bills have set up very good plans. I would feel that either bill, as I see it here, or the combination of the ideas, would work very well. I believe that medical research is well cared for, and, as Dr. Smith outlined, there would be no trouble, as I see it, working that out.

One point I think we should make very sure, that the man who performs the research should not be hampered in his methods.

We must make very sure that he is left freedom of action, that any program that is set up should insure that side, because the man on the lower level is the man who is going to carry out research.

I must disagree with the statement that was made that the Government should be set aside, so to speak, in research problems. I think we must have the closest integration, and I have no fears about Government running away or dominating research. I think it has been proven in this past war that our governmental organizations function beautifully with our civilian organizations, and for that reason, I have no fear on that side.

I think there would be no difficulty finding somewhere in our governmental organizations very excellent representatives, men who are broad enough to throw aside personal feelings. I have no feeling at all, in setting up members of the subsidiary boards, that it would be necessary, let me say, to have the Surgeon General of the Army or the Navy or the Public Health as a member. That is not necessary at all, because there are plenty of excellent representatives who could take that place. Certainly we would not want any such thing to come about as to where the Government took over and attempted to direct research. That I don't think would be good at all.

So, in looking over this problem, I believe we must take care of our topside organization, making the board a definite policy-making organization, giving it full responsibility to discharge the same, and then as an adviser in all matters making the director responsible to carry out those policies, always with full authority in the board to recommend his removal if he fails to discharge that responsibility.

I think that is all I have to say, Mr. Chairman.

Senator MEAD. Well, that is a very fine statement, Admiral. We are glad to have it and we know that you have given it a good deal of thought and that your experience in the Government side of it, and with reference to proper organizational methods are very valuable and will help the committee in its decision. We appreciate your presence here and the statement you made.

All right, Dr. R. E. Dyer, United States Public Health Service, and perhaps, if he is here, Deputy Surgeon General W. F. Draper.

Dr. DRAPER. With your permission, sir, I will ask Dr. Dyer to present the testimony.

Senator MEAD. All right. That will be satisfactory.

TESTIMONY OF ASST. SUR. GEN. R. E. DYER, DIRECTOR, NATIONAL INSTITUTE OF HEALTH, UNITED STATES PUBLIC HEALTH SERVICE

Dr. DYER. Mr. Chairman, I appear here under Dr. Draper's instruction in response to your request to Surgeon General Parran to testify on pending legislation for the establishment of a National Science Foundation, as embodied in S. 1297 and S. 1285. The latest drafts of these bills, I believe, are the committee prints of October 8 and 12, respectively.

As you know, Dr. Parran is attending the Quebec conference to establish a permanent United Nations Organization for Food and Agriculture. Dr. Draper has asked me to present the thinking of the United States Public Health Service on this subject and to answer any questions which you may wish to ask and which fall within the competence of my experience.

In your letter to the Surgeon General you requested him to testify on the general purpose, the organizational plan, and specific provisions of the legislation which affect the support and development of research in the medical sciences.

Naturally, Mr. Chairman, the Public Health Service has been deeply interested in the report of Dr. Bush and his colleagues on Science, the Endless Frontier, as well as in the pending legislation. Our organization has been continuously engaged in scientific research, both basic and applied, for over 50 years. During that time, the Congress has given increasingly broad authority to the Public Health Service for conducting and fostering research in the health and medical sciences. Appropriations to the Service for its research facilities and activities have increased likewise, although not as yet to the point where funds permit us to carry out fully the responsibilities authorized by Congress. In the past 10 years annual appropriations for research activities have averaged about 3 million dollars, exclusive of capital investments. The laboratory facilities of the Public Health Service have been constructed at a cost of some $8,000,000. Thus, the Public Health Service is the principal Federal agency engaged in health and medical research, not only as to facilities and legal functions but also as to personnel and experience.

With such a background of public responsibility and continuous scientific activity, the Public Health Service could not fail to endorse wholeheartedly the broad objectives of the Bush report and of the

pending legislation. We recognize that only through the advancement of science can we fulfill our other major responsibilities; namely, protection and improvement of national health and provision of medical care for our legal beneficiaries. In his annual report to Congress for the fiscal year 1944, the Surgeon General of the Public Health Service formulated the elements of a national health program. One of these six elements is the expansion of Federal support for scientific research. I should like to read that portion of the report:

> The Nation should continue to support and encourage both public and private research to a degree commensurate with the present coordinated programs of research in war medicine. Medical science is one of the most dynamic, most rapidly developing sectors in the search for new knowledge. Even modest expenditures for pure and applied research in medicine and the basic sciences have already yielded results out of all proportion to the financial outlay. The economy and effectiveness of a comprehensive health program will depend heavily upon the discovery of better methods to prevent and cure disease.
>
> Governmental funds for research should be available through grants-in-aid to scientific institutions, to insure continuity of research and to enlist cooperation in investigations requiring a variety of professional skills. Problems selected for public support should include basic and laboratory and clinical research, as well as administrative studies and demonstrations.

We have studied carefully the proposed legislation, as well as the excerpts from reports issued by the Subcommittee on War Mobilization, September 28 (S. Doc. No. 92), and the published hearings on scientific legislation. These documents have impressed us with the sincere concern of the authors of these bills and of the committee members that the final legislation shall express clearly the intent of the Congress and the will of the American people.

It is understood that the intent of the proposed legislation is, broadly, to provide adequate Federal support and encouragement for scientific research and training, and to secure cooperation among research and development organizations in the public interest, without encroaching upon the intellectual freedom and independence of individuals and institutions engaged in such activities. The problem is so to draft the legislation that, in the future, the intent of Congress may not be misinterpreted by any participant in the program, whether the new foundation itself, another Federal agency, or a private institution.

Despite the fact that many controversial points have been partially overcome in the present working drafts of S. 1285 and S. 1297, the Public Health Service and its legally established advisory councils believe that two major points require further clarification. These are:

1. Scientific freedom of Government agencies now engaged in research under statutory authority from Congress.

2. Relation of Federal research agencies to the proposed foundation.

We are just as much concerned with preserving the scientific integrity and independence of our organization as any university administrator or director of a private foundation. As the President stated in his message to Congress on September 6, 1945: "Although science can be coordinated and encouraged, it cannot be dictated to or regimented." The very organization of the Service during its more than 50 years of research has protected our scientists and our investigational activities from the pressures of private gain to a degree equal if not greater than that afforded in other institutions. This has been true since the 1880's when research in the health sciences required hazardous field investigations of epidemics of cholera and yellow fever. As a

result, we have been able to develop a diversified program of basic and applied research, to recruit personnel of the highest caliber, and to conduct long-term investigations based upon the scientific method and freedom of individual thought.

In a series of laws enacted since 1901, the Congress has expanded the facilities and authority of organized research in the Public Health Service. In 1901, the hygienic laboratory was established. In 1902, the biologics control law was enacted, giving the Service the responsibility for licensing the manufacture of biologic products sold in interstate commerce. A vast amount of basic and applied research in bacteriology and immunology has gone into the establishment of the United States standards for the purity and potency of biologic products. In 1912, the research function of the Service was broadened to include besides the investigation of infectious and contagious diseases, authority to "study and investigate the diseases of man and conditions influencing the propagation and spread thereof," including the pollution of inland waters. The act of 1930 creating the National Institute of Health confirmed that authority and also established a system of fellowships in the Institute. In the same year, the Service was given the authority and responsibility to conduct research in narcotic drug addiction and related subjects, as well as upon the causes, prevalence and means for the prevention and treatment of mental and nervous diseases. Title VI of the Social Security Act of 1935 greatly expanded the research program of the Service through its authorization of annual appropriations of $2,000,000 for this purpose.

The National Cancer Institute Act of 1937—in the drafting and sponsorship of which Senator Magnuson played an important part—established the principle of grants-in-aid to responsible public and private institutions for medical research projects. It will be recalled that the testimony on that legislation stressed the importance of basic research, of long-term projects without promise of immediate results, and of complete freedom to the cooperating institutions in the use of funds allotted to them and in the conduct of their cancer-research programs. The act stated that the establishment of the Institute was for the purposes of—

> Conducting researches, investigations, experiments and studies * * *; assisting and fostering similar research activities by other agencies, public and private; and promoting the coordination of all such researches and activities and the useful application of their results * * *."

The National Venereal Disease Control Act of 1938 included specific language authorizing the Public Health Service to conduct research in this field.

The Public Health Service Act of 1944 (Public Law 410) incorporates the above-mentioned research functions of our organization and gives us even broader authority. In fact, the basic law of the Service gives the agency all of the authority in reference to health and medical research that is contemplated for the proposed function, in those fields. The Service is authorized to—

> conduct, and encourage, cooperate with, and render assistance to other appropriate public authorities, scientific institutions and scientists in the conduct of, and promote the coordination of, research, investigations, experiments, demonstrations, and studies relating to the causes, diagnosis, treatment, control, and prevention of physical and mental diseases and impairments of man, including water purification, sewage treatment, and pollution of lake sand streams.

The language could scarcely be broader.

Specifically, we are authorized to provide research fellowships, and to make grants-in-aid to universities, hospitals, laboratories, and other public or private institutions, and to individuals for such research projects as are recommended by our advisory councils.

Mr. Chairman, the Public Health Service wishes to be clearly understood as not holding the point of view that, because we have this broad authority, we should therefore seek to monopolize this field.

On the contrary, we believe that such a monopoly would be undesirable, no one agency—however broad its powers—will be able to monopolize the field of health and medical research, at least not under our system of government. The sole interest of the Public Health Service is in ensuring its freedom to develop its program of research and training in accordance with the authority granted it.

Section 4 (d) of the October 8 print of S. 1297 (p. 7, 1.24) clearly expresses the intent of the Congress to safeguard the independence of Government agencies engaged in research and development activities.

May I read from that:

> The activity of the foundation shall be construed as supplementing, and not superseding, curtailing, or limiting any of the functions or activities of any Government agencies authorized to engage in scientific research and development. Funds allocated by the Director to other Government agencies shall be utilized for projects designated by the Director, and undertaken on behalf of the foundation, and shall be in addition to and not in lieu of funds regularly appropriated to such other Government agencies.

This principle has been supported in various reports of the committees and in the hearings. No one intends that the proposed legislation should be interpreted in any other way. This section, however, appears to me to express more clearly this intention than does the comparable section (sec. 9 (f)) in the amendment to S. 1285 (p. 12, 11.6–10), and is similar to the language in section 2 (b) of S. 825 as reported by Senator Byrd from the Committee on Naval Affairs.

On the other hand, section 6 of the October 8 print of S. 1297 (p. 9, lines 6–15) can be interpreted to nullify the provisions of section 4 of the same amendment. Also, subsection (a) of section 6 appears to discriminate against Government agencies. In the first sentence, a survey of "federally financed research and development activities" is required. This would bring the entire programs of Government agencies under the review of the Director, whereas only the federally financed projects of outside institutions would come under such scrutiny. The second sentence, however, provides that only Government agencies shall furnish detailed data and reports.

Unnecessary investigations and reports are not only time-consuming but may very well hamper the freedom of the workers. It would seem quite proper that the foundation receive full data and reports on work which it finances, either in Government agencies or elsewhere, but for work conducted by Government agencies under their statutory authority with funds provided directly by Congress, only general information sufficient to permit the foundation to develop its program should be required.

Even more important, however, is the fact that subsection (b) clearly places the Director between the Government agencies and the President, to whom they are already responsible by law. It provides

that the Director "shall evaluate such survey data in the light of the objectives of this act, and shall prepare and send to the President and agencies concerned, recommendations for better effectuating these objectives." This language might well be interpreted as requiring the approval of the foundation before a Government agency could submit to the Congress requests for funds to continue previously authorized and established research programs.

The Public Health Service would recommend that section 6 be eliminated, or at least so modified as to make clear that the intent of Congress as expressed in section 4 (d) with respect to Government agencies is to be preserved. If retained, section 6 should contain a specific provision that it is to be interpreted in the light of section 4 (d).

There can be no question that the Director should be kept informed upon the programs financed by the foundation; and he should, through his division chiefs and advisory committees, be well-informed as to the general programs of research and development throughout the country. Without such information, he could scarcely develop the program of the foundation. However, safeguards should be placed in the legislation lest this responsibility be interpreted as authority to interfere in the independent development of research programs in other institutions.

Among the purposes of S. 1285 (sec. 2 (g), p. 2, 1, 20), is "to correlate the foundation's scientific research and scientific development programs with those undertaken by public and private research groups." There are two ways in which this purpose can be accomplished: One by direction and control; the other, by cooperation among all groups concerned. Those words, "direction and control" if translated into action, are fatal to an institution and to the work of individual scientists.

Since it is the purpose of the pending bills to insure the freedom of scientific institutions, both public and private, united effort is obviously the method of choice. For this reason, the Public Health Service strongly urges that Government research agencies be represented on the boards and advisory committees of the foundation, as provided in S. 1297.

I have seen the effective cooperation of such a group in the Committee on Medical Research, and also in the National Advisory Health Council of the United States Public Health Service. This Council was first created by law in 1930. It succeeded an advisory committee to the old hygienic laboratory established in 1905.

The committee may be interested in the statutory composition of the Council:

Under the basic law of the Public Health Service (Public Law 410, sec. 217 (a)), the Council is composed of 14 members. The law specifies that "the Director of the National Institute of Health, and three experts, one each from the Army, the Navy, and the Bureau of Animal Industry, to be detailed by the Secretary of War, the Secretary of the Navy, and the Secretary of Agriculture, respectively, shall be ex officio members," that is, voting members. Ten members are appointed by the Surgeon General, with the approval of the Federal Security Administrator; they are "persons not otherwise in the employ of the United States, skilled in the sciences related to health." Our experience with this pattern of an advisory and consultant body has been most satisfactory.

During the war, many pressing problems made necessary an expansion of Federal support of research, as well as the establishment of a coordinating agency, the Office of Scientific Research and Development. The National Research Council was activated with many special advisory committees, at the same time. The results of the war research conducted under these programs need no further comment. The lesson to be learned from this experience, with respect to peacetime research, is that the OSRD worked smoothly with the Government agencies, the universities, and the National Research Council, because representatives of all these groups were on the various boards and committees of the OSRD.

I had the pleasure of serving on the Committee on Medical Research under Dr. Richards' chairmanship throughout the war. Only through this democratic approach can the desired correlation be secured, without the direction and control of the foundation.

The advisory committees and subcommittees of the proposed foundation should certainly have representatives from the Government's research agencies, and these should be experts in their respective fields. The legislation should specify not only the representation of Government agencies but also the character of such representation on the technical advisory committees and subcommittees of the foundation.

It was requested in your letter that the Public Health Service comment upon the organizational plan of the foundation. We recognize that the question of whether the foundation is to be administered by a board or a single director has been much discussed among interested groups and at these hearings. Our advisory councils after discussion in joint session, favored (without making a specific recommendation), the plan of a semi-autonomous board which would elect its own executive. This plan is acceptable to the Public Health Service.

Other provisions I wish to recommend are:

1. The Public Health Service approves the inclusion of the word "health" in the name of the Division for Medical Research (S. 1297, amendment, p. 2, line 6; and p. 4, line 19). Aside from the disciplines commonly accepted as pertinent to medical science, the Public Health Service and the Nation's health departments are concerned with such disciplines as epidemiology, statistics, and engineering.

2. The Public Health Service also approves the inclusion of the social sciences. It is impossible to study man apart from his environment. Many problems of public health are dependent for their ultimate solution upon greater understanding of the social and economic conditions. Geography, demography, sociology, and economics are all essential considerations in the study of disease.

3. The Public Health Service has represented the United States at international health congresses since the earliest of such meetings. Our experts have been called upon not only officially, but also as individuals.

Section 8 (a) of S. 1297 appears to be drafted in such a way as to avoid the interpretation that the Director of the new foundation would also be the arbiter of official representation at scientific assemblies.

4. I would call the committee's attention to section 8 (a) of S. 1297, page 14, lines 3–9. The disposition of property (materials and equipment) used in a long-term project financed by the foundation may impose heavy burdens both upon the Government and the cooperating

institution. Problems of this type have already arisen in the dissolution of health and medical projects transferred from OSRD to the United States Public Health Service.

Our experience has been that the better method is the allocation of an all-purpose grant for a particular project. For example, the Cancer Institute made grants to the University of California and to Washington University for constructing a cyclotron. That is the purpose of the grant, but how they spend the money is up to the institution, no strings attached. Similarly, the National Institute of Health has made a grant to the University of Utah for a study of muscular dystrophy; if any part of this money is used for equipment, it belongs to the university, since under the grant-in-aid system that money has become part of the university's budget to be expended for the purpose of the study as it sees fit.

CONCLUSION

Mr. Chairman, I think I express the viewpoint of the Public Health Service as a whole and of my scientific colleagues in particular, when I say that we sincerely hope that the National Science Foundation will be established, in order that the benefits of wartime collaboration by Government, the universities, and industry may be extended to the even larger tasks of peace. We are confident, too, that the foundation will be so established as to preserve freedom of scientific thought and endeavor, the independence of all research institutions, and cooperation of all concerned, through legal representation of Federal agencies, public and private institutions, and the public. Without the preservation of these important elements, the proposed foundation would fail in its primary objective—the advancement of science.

The Bush report, the reports on several of the bills dealing with research, as well as the testimony already presented before these committees have stressed the importance of the research activities of Government agencies. In connection with the health and medical sciences, I should like to introduce into the record two letters from Dr. J. E. Moore of the Johns Hopkins University School of Medicine and chairman of the Subcommittee on Venereal Diseases of the Committee on Medical Research, OSRD. Dr. Moore has long served as a consultant to the Public Health Service and as a member of the Cooperative Clinical Group which has done such outstanding work in promoting and guiding fundamental research on syphilis for the past 20 years. These letters are to Dr. A. N. Richards, chairman of the OSRD Committee on Medical Research, and comment particularly on the recent investigations and brilliant results in the penicillin treatment of syphilis, part of which was done in our own laboratories and hospitals.

I believe your committees will also be interested in a few examples of the research activities of the Public Health Service. Not only have the contributions of our scientists resulted in the solution of many specific problems, but they have also advanced fundamental knowledge in various fields. The nature and quality of research in the Public Health Service is internationally known; during the war, the National Institute of Health was one of the few remaining free institutions conducting a broad program of research in the health and medical sciences. May I submit for the record a short statement presenting a few examples of the scientific contributions of the Public Health Service?

In conclusion, I would like to present for the record the report submitted by the National Advisory Health Council and the National Advisory Cancer Council at a joint meeting, September 28, 1945, to consider the pending legislation.

Senator MEAD. Doctor, I think it will be very helpful to the committee if you will submit for the record in some detail the record of your agency in the matter of special study and research work, as authorized by the Congress.

Dr. DYER. I shall be glad to do that.

Senator MEAD. You left some very fine suggestions with the committee, and I take it you have given some thought to the possible usurpation of the authority of existing agencies by a new agency that might be set up as a result of this legislation.

You have also left the thought, with me at least, that there is room for this foundation and also for a continuation of the authorized research work which your agency is now doing.

Dr. DYER. I think you have the points I tried to make very well.

Senator MEAD. Fine. I appreciate it very much, Doctor, and you will add to the record any helpful suggestions that may come to mind.

(The information requested is as follows:)

EXAMPLES OF THE SCIENTIFIC CONTRIBUTIONS OF THE UNITED STATES PUBLIC HEALTH SERVICE

1. The old hygienic laboratory pioneered the work in this country upon anaphylaxis and hypersusceptibility, following injection of biologic products for the prevention of disease.

2. As stated earlier, administration of the biologics control law required much fundamental work in the establishment of standards. Improvement in smallpox vaccination in this country is due chiefly to the work of the Public Health Service upon vaccine virus, and the sequelae of vaccination. Standardization of diphtheria antitoxin, antimeningitis serum, scarlet fever serum, and antitetanus serum has required much long-term research, with comparable results.

3. The discovery of the cause, prevention, and cure of pellagra by Joseph Goldberger and his coworkers initiated the continuing interest of the Public Health Service in dietary deficiency diseases.

4. In the field of general bacteriology, Public Health Service studies of oxidation-reduction phenomena and hydrogen-ion concentration have had a profound effect upon techniques employed in public health laboratories throughout the world.

5. Researches on sugars and enzymes have contributed much fundamental knowledge in the fields of chemistry and biochemistry.

6. Our work upon water pollution has done more than the contribution of any other single institution in the elaboration of general principles, the perfection of tests, and in the study of the phenomena attending the treatment of sewage by activated sludge.

7. Since 1909, the Public Health Service has been the leading institution in the study of typhus fever and other rickettsial infections, such as Rocky Mountain spotted fever and Q fever. As a result, we have demonstrated the flea transmission of endemic typhus, and the cross-immunity of this infection with louse-borne epidemic typhus. A vaccine for the prevention of Rocky Mountain spotted fever was discovered by Public Health Service men, and it has been produced since 1930 at our Hamilton, Montana laboratory. More recently, an anti-typhus vaccine was developed by one of our scientists. In mass production by the Public Health Service and private laboratories, this vaccine has protected United States armed forces from typhus in the present war, with the remarkable record of not one fatality.

8. Studies upon virus diseases by the Service have resulted in: isolation of the virus which caused the epidemic of encephalitis in St. Louis in 1933; discovery of lymphocytic choriomeningitis; discovery of a hitherto unknown disease which caused an epidemic in Louisiana in 1943; and successful transmission of poliomyelitis to cotton rats, thus giving science a new and inexpensive experimental animal for the study of this disease.

9. Beginning with World War I, the Public Health Service has been an important agency in industrial hygiene research. This broad field as yet remains neglected in the universities and medical schools. In the early years following World War I, studies of occupational hazards in many important industries were made, establishing the bases for reduction of occupational morbidity and mortality. In recent years, studies on the toxicology of a vast number of substances used in the manufacture of munitions and in other military operations have made direct contributions to the war effort.

10. Cancer research, since 1937, has been of the most fundamental type. Important contributions have been made in biochemistry, genesis of breast cancer in mice, and in the synthesis and mode of action of cancer-producing substances. In 1943 the National Cancer Institute for the first time succeeded in transforming normal cells into cancer cells in the test tube.

WAR RESEARCH

During the past 5 years, the Public Health Service has, of course, directed all of its scientific resources to the pressing problems of the war. A national agency such as the Service must utilize all its resources not only to perform the immediate tasks, but also to visualize future problems and it must initiate studies for their solution. An example of this responsibility for anticipating the needs for investigation is our war program in malaria.

1. *Malaria research.*—As early as 1939, the Surgeon General of the Public Health Service began to stock-pile quinine for the use of this country. At the same time, he directed the National Institute of Health to initiate studies to discover new antimalarial drugs. After the establishment of the OSRD, this study was greatly expanded.

2. *Aviation medicine.*—The effects of rapid compression and decompression of the atmosphere upon flight personnel are comparable with their effects upon caisson workers and divers. Caisson sickness, or "the bends" has long been under study by the Public Health Service. In January 1940 our pressure chambers were converted to military research. Our facilities permit the reproduction of pressure and temperature changes which occur in parachute jumps from 40,000 feet. We can maintain temperatures as low as 67° below zero; or simulate a tropical climate.

For the United States Navy, our industrial hygiene research laboratory has carried on continuous studies since 1941. The chief problems has been to provide flight personnel with adequate oxygen-breathing equipment. In studies to prevent leakage in gas masks, our own personnel acted as subjects of the exhaustive tests made of equipment. An emergency mask was developed for use in combat. Our work on a standard mask used by the armed forces converted it from a protective mask to an instrument for resuscitation in emergencies. Dark-adaptive goggles were developed by our laboratory for Navy use by night pilots and lookouts. In addition, our researches have made substantive contributions to the fundamental knowledge of the physiologic effects of high altitude and combat flying.

3. *Airborne infections.*—At the outset of the war, the National Institute of Health and the National Cancer Institute were engaged in fundamental studies on the effect of ultraviolet radiation on living cells. During the war, our preliminary findings led to an applied study with the Navy, to determine the effectiveness of ultraviolet radiation on the control of air-borne infections, such as colds and influenza.

4. *Explosives.*—For the United States Army, our industrial hygiene laboratory has done the basic and applied research upon the toxicology of TNT, the powerful new explosives RDX and PETN. The toxicology of lead amide, used for detonating the explosive charges in shells, was likewise unknown until our studies were completed.

As a result of these projects, methods for the protection of workers exposed to toxic substances have been devised and put in use by the responsible authorities. Some concept of improvements made in protecting munitions workers may be gained from the following figures. In a period of 7½ months during World War I, 475 deaths occurred among 17,000 cases of TNT poisoning in the United States. During the entire period of World War II, only 22 deaths from this cause have occurred among several hundred thousand workers exposed to TNT.

5. *DDT.*—In September 1943, the Public Health Service was able formally to advise the Army, the Navy, the Department of Agriculture and OSRD, that DDT in the recommended mixtures could be used safely by the armed forces,

with certain precautionary measures which were defined. This was the result of an intensive study—24 hours a day—upon the toxicity of DDT as a dust, mist, spray, or aerosol, by various means of exposure. Several of our laboratories were involved, with the Food and Drug Administration and the University of Cincinnati cooperating.

6. In 1944 the National Institute of Health initiated a long-range study of the physiological effects of nuclear radiation exposure. Our subjects are the cyclotron staff of the Carnegie Institution of Washington whose experimental contributions to the study of atomic energy are well known. Their work involves risks from exposure to neutron bombardment and radioactive emanations.

7. *Yellow fever.*—This committee may recall the outbreak of jaundice in the Army of the United States in 1942. At first it was thought that the disease was a mild form of yellow fever resulting from vaccination against that disease. The same year, Puerto Rico and the Virgin Islands suffered similar outbreaks, following widespread vaccination. A Public Health Service officer investigating the problem for 3 years has discovered that the cause—a filterable virus is present in the serum of a person developing infectious jaundice in the early stages, as well as for some time after recovery. Thus, many individuals may carry the virus in their blood serum, and if human serum is used, as in the preparation of the yellow-fever vaccine, it may produce jaundice. The virus can be rendered inactive if the serum is exposed to ultraviolet radiation; this discovery has a practical application, in that it suggests a method for treating human serums before they are used for treatment of other individuals.

8. *Typhus fever.*—Reference has already been made to the work of the Public Health Service in this disease. During the war, we have intensified our research upon numerous foreign foreign strains, notably scrub typhus, or tsutsugamushi fever, the Japanese form of the infection which is transmitted by mites. Several of our research scientists have contracted this disease in line of duty; two of them died as the result of laboratory infection.

9. *Exotic diseases.*—Schistosomiasis, filariasis, trypanosomaiasis, and leishmaniasis are a few of the numerous exotic diseases to which our troops have been exposed in this war. In foreign countries, amebic and bacillary dysentery have been excessively prevalent. The zoology laboratory of the National Institute of Health has done notable work in the diagnosis of these conditions, in developing methods for purifying water used by combat troops, and in determining the potential dangers of these diseases to civilian health in the United States.

10. *Venereal diseases.*—Since World War I, cooperative studies conducted by the Public Health Service with outstanding public and private institutions have made important contributions to the scientific knowledge and control of venereal diseases. Through such studies, there have been brought about (1) vast improvements in the performance of serologic tests in State health laboratories; (2) development of standard methods of syphilis therapy. The Public Health Service first demonstrated the value of the sulfa drugs in the treatment of gonorrhea. In 1943 penicillin was first used in the treatment of syphilis by a Public Health Service officer. Much of the research on the use of penicillin in syphilis therapy has been done in our hospitals and laboratories.

11. *Continuous caudal anesthesia.*—When in 1937 the families of United States Coast Guard personnel became beneficiaries of the Public Health Service, our hospitals for the first time in their history became concerned with obstetrics. Five years later, two of our young officers made an outstanding contribution in that field with the discovery of continuous caudal analgesia as a means of alleviating pain in childbirth. This method has been further explored and developed in a broad cooperative study with outstanding hospitals and universities.

National Advisory Health Council and National Advisory Cancer Council of the Public Health Service—Joint Report on Proposals for a National Research Foundation, September 28, 1945

The joint meeting of the Councils was convened to consider specifically the relation of the Public Health Service to the report made by Dr. Vannevar Bush to the President, and to pending legislation pertaining to the implementation of the report.

Each member of the Councils, at the request of Surgeon General Parran, expressed his opinion regarding the relationship of the Public Health Service with the proposed National Research Foundation or any over-all research body which the pending bills would create.

The consensus of the Councils may be summarized as follows:

I. The Bush report is a magnificent and distinguished document which outlines a plan for stimulating basic research in civilian research institutions and for continuing the close and profitable cooperation between civilian and governmental research agencies. To implement the recommendations of the report, the formation of a new body, the National Research Foundation, was proposed. The report expressed the belief that the existing governmental research agencies should be further developed and provided with more funds. It further emphasized that, although a new independent agency is needed to develop and foster research, this new agency should in no way conflict with existing governmental agencies, but should "supplement the research activities of these agencies in a valuable manner." The report proposes that a National Research Foundation would provide for the training of scientific personnel, promote basic research, and cooperate with governmental research agencies. These aims and views expressed in the report were endorsed by the Councils.

II. (*a*) The Councils agreed that pending legislation is not clear regarding the relation of the proposed new body to the budgetary and research policies of existing governmental agencies. Although the various bills may be interpreted broadly as carrying out the intent of the Bush report, the omission of specific language may permit the interpretation that the National Research Foundation would exercise direct or indirect control over the budgetary and research policies of the existing agencies. The Bush report visualized only a consultative, advisory, and cooperative relationship.

(*b*) In the firm belief that the Public Health Service should retain autonomy in its research activities, the Councils were of the opinion that pending legislation should be clarified.

(*c*) Under existing law (Public Law 410, sec. 301, par. (c) and (d)), the Public Health Service has broad authority to coordinate and conduct research upon the physical and mental impairments and diseases of mankind, to allocate grants-in-aid for such research to other institutions, upon recommendation of its advisory councils, and to provide fellowships for the training of scientific personnel in these fields.

In this connection, the Councils recommended that the Public Health Service continue to develop and expand its research and training programs, as authorized by Congress, both in its own facilities and through grants-in-aid to universities and other institutions.

III. A study of the pending legislation shows lack of agreement in regard to the representation of governmental agencies on the board or executive organization of the proposed National Research Foundation. In the medical portion of the Bush report (pt. II, p. 57) it is stated that "men who are experienced in research and who understand the problems of the investigator should administer the agency and its policies." The Councils agree with the intent and implications of this statement, but they believe that governmental agencies should be represented on such boards and advisory committees as may be set up in or by the new body.

This opinion is based on the reasonable assumption that governmental agencies would appoint as their representatives men "who are experienced in research;" but it appears advisable that this requirement should be clearly expressed in the proposed legislation.

IV. In general, it was the opinion of the Councils that appropriate legislation can maintain in peacetime the cooperative relationship which was maintained throughout the war among governmental agencies, the Office of Scientific Research and Development, and civilian research institutions. In the establishment of a National Research Foundation, the Councils favored the appointment of a board to carry out the powers and purposes of the foundation, and the choice by that board of its own chairman and other officers. The Councils felt, however, that members of the board should be selected from among persons nominated to the President by the National Academy of Sciences and governmental research agencies.

It was the opinion of the Councils that either (*a*) a new bill should be written as a cooperative enterprise of all governmental agencies concerned and the appropriate committee of the National Academy of Sciences; or (*b*) that the defects of proposed legislation be remedied by amendments such as those recommended by the Senate Committee on Naval Affairs in its report on S. 825 (Rept. No. 551, Calendar No. 549), July 28, 1945, as follows:

1. The board shall in no way relieve governmental agencies of their responsibility for, or authority over, research and development work under their legal

cognizance. This act shall not be construed as superseding, curtailing, or limiting any of the functions or activities of existing governmental agencies now authorized to engage in scientific research and development, or as authorizing the board to exercise any supervisory direction or power of regulation over such functions or activities in any manner. Funds allocated by the board to other governmental agencies shall be utilized for projects designated by the board and undertaken on its behalf, and shall be in addition to, and not in lieu of, funds regularly appropriated to the agency concerned.

2. Wherever practicable the board shall make use of the facilities and services of governmental agencies legally available for scientific research or development work, and wherever practicable it shall conduct research or development projects related to the legally authorized functions or activities of any governmental agency through or in cooperation with such agency. The said agencies are hereby authorized to make such facilities and services available to the board and to participate in the conduct of its projects, on terms mutually agreeable to the board and to the agency concerned. The board shall not operate laboratories under its own auspices.

V. To implement the foregoing opinions, the following motions were passed unanimously by the Councils:

1. That proposed legislation should be amended to include statements to the effect that autonomy in the development and conduct of their research programs should be maintained by those governmental agencies now engaged in such activities.

2. That there should be governmental representation on such boards and advisory committees as may be set up in connection with the proposed National Research Foundation.

3. That the joint report and recommendations of the Councils be brought to the attention of other scientific groups, both public and private, now considering the proposals for a National Research Foundation.

(Copy)

NATIONAL RESEARCH COUNCIL,
Washington 25, D. C., October 13, 1945.

Dr. A. N. RICHARDS,
Chairman, Committee on Medical Research,
Washington 25, D. C.

DEAR DOCTOR RICHARDS: This is in amplification of my letter to you of October 9 concerning a National Research Foundation. At the time I wrote the letter I was unaware that neither of the two bills now before the Congress seems to provide in appropriate form for a continuation of research by Governmental bodies, e. g., the United States Public Health Service, the Department of Agriculture, etc. As I understand the situation, the passage of either the Magnuson or the Kilgore bills might operate in such a manner as to diminish the direct availability of funds to Governmental agencies by diverting them to the National Research Foundation; might make it necessary for a governmental agency, such as the Department of Agriculture, to approach the National Research Foundation for a grant-in-aid; and might provide for some degree of censorship of research activities planned by governmental agencies.

The importance of research carried out by Government itself cannot be overemphasized. The achievements of the members of the United States Public Health Service in many fields, for example pellagra, tularemia, and rickettsial diseases among others, have been of the greatest importance to American medicine.

In my opinion, if the two bills now before the Congress do not provide adequately for continuation of research by governmental agencies, without the necessity of passing funds or approval of projects through the National Research Foundation, a provision which will guarantee the continuation of Governmental research should be incorporated into one or the other, or an amalgamation of the two.

Sincerely yours,

J. E. MOORE, M. D.,
Chairman, Subcommittee on Venereal Diseases,
Associate Professor of Medicine,
Johns Hopkins University.

OCTOBER 9, 1945.

DR. A. N. RICHARDS,
Chairman, Committee on Medical Research, Washington 25, D. C.

DEAR DR. RICHARDS: This acknowledges receipt of your telegram of October 9, 1945, asking me to submit to you a frank and considered statement of my views concerning the desirability, character of organization, and conduct of a postwar governmental research foundation, such as is envisaged in the Kilgore and Magnuson bills.

I have had the opportunity to see at close hand the accomplishments of American investigators during the war years under contracts recommended by the committee on medical research to the Office of Scientific Research and Development. Most if not all of these contracts were for the specific purpose of answering questions of urgent military importance to the armed forces. They were therefore in the field of applied rather than "pure" or "fundamental" research. Nevertheless, the advances in medical science made under them are enormous, and accelerated far beyond anything accomplishable under prewar conditions.

A development of particular importance under CMR has been that of cooperative medical investigation. Several or many investigators have shared portions of a problem too large for any one to approach alone. The pooling of information thus accomplished has permitted within a short time the partial or complete solution of problems which, attempted individually, would have required many years.

In the medical field an outstanding example, with which I am personally most familiar, is the investigation of the efficacy of penicillin in the treatment of syphilis. Within 2 years, the organized effort of many OSRD contractors, working together under CMR and NRC auspices, has provided more information as to the value of this drug than was gathered for arsenic (salvarsan—606, and its derivatives) by individual effort in the 34-year generation 1909–43. Within a year after its inception, this cooperative study permitted the armed forces to adopt penicillin as routine for the treatment of recently acquired syphilis. This was done with complete safety to the infected patient, and accomplished results within a period of 10 days equal to those previously attainable from older forms of treatment (at some risk of incapacitating illness or death due to treatment itself) within not less than 6 months. The saving of manpower has been of great benefit to the prosecution of the war. The cooperative study of penicillin in syphilis is not yet complete, because of the complex and chronic nature of the disease; but the results so far achieved indicate that with several more years of organized effort the place of the drug in this important disease will be completely and accurately defined, to an extent never heretofore accomplished with any method of treatment during the 450 years' history of syphilis.

No agency other than the United States Government itself could or would have provided the funds necessary for the study of penicillin in syphilis (as I can testify as a result of 25 years of effort to raise money from private philanthropic sources for research in this disease); nor could any other agency than Government itself have arranged and carried out the necessary cooperation of many medical investigators.

What has been said of medical research in general, and of penicillin in syphilis in particular, is, of course, much more spectacularly emphasized by the enormous developments (under OSRD auspices) in the field of atomic energy.

The future of medical research seems to me dependent in part on the provision of adequate sums of money, and in part—perhaps in largest part—on how that money is spent.

As for the money itself, private philanthropy, whether from individual donors or from foundations, is no longer able to supply the need. The only visible alternative appears to be governmental moneys, preferably on a Federal rather than a local basis.

I am in complete accord with the discussion, conclusions, and recommendations made by Dr. Vannevar Bush in his July 1945 report to the President, Science: The Endless Frontier. I favor heartily the establishment of a National Research Foundation, with a Division of Medical Research. With Dr. Bush, I emphasize that there are two types of medical investigation: broad and basic studies, i. e., so-called "pure" or "fundamental" research; and coordinated attack on special problems. The latter depends in large part upon the former. "Progress in the war against disease results from discoveries in remote and unexpected fields of medicine and the underlying sciences."

Even more strongly than the Bush report, or the report of the Medical Advisory Committee on which the condensed report is based, I would stress the inseparability of medical education and medical research. The universities of the country are the agencies which train young scientists, and which provide them with the wide essential background of contact with their fellows in various branches of science, to an extent which a nonuniversity connected research institute cannot accomplish.

The success or failure of a National Research Foundation depends, not on money alone, but even more largely on the administration of it. Politics, bureaucracy, red tape, incompetent leadership—these can render sterile and futile the expenditure of any sum. I agree wholeheartedly with the point of view expressed in this respect by Mr. Isaiah Bowman, president, Johns Hopkins University in, his testimony of yesterday before a congressional committee considering the establishment of a National Research Foundation. Brains without money are helpless greatly to advance human knowledge; but money without brains is even more useless.

Sincerely,

J. E. Moore, M. D.,
Chairman, Subcommittee on Venereal Diseases,
Associate Professor of Medicine,
Johns Hopkins University.

All right, now, we have been in session a little over an hour, and we have heard three witnesses. We have five more to come before we will have to leave to hear President Truman, and I understand that they are all very busy, and all the witnesses have made a great sacrifice to be here, and so if we at the committee end of the table can be patient with them, and if they can be as brief as good argument will permit, we will finish in time.

The next witness will be Maj. Gen. Norman T. Kirk, Surgeon General of the War Department. General Kirk, you may come up with your aides and those who will assist you. General, have you a prepared statement?

General Kirk. Yes. I have prepared a somewhat lengthy written statement, but can express the essential points in comparatively few words.

TESTIMONY OF MAJ. GEN. NORMAN T. KIRK, SURGEON GENERAL, UNITED STATES ARMY

General Kirk. I believe it to be indisputable that governmental support of scientific research is essential. I wish to emphasize that this is no less true in medicine than in that of weapons and other fields of science. The experiences of the past war have established that fact beyond argument.

The Medical Department of the Army entered the war with the knowledge that it could commission and recruit to its membership from the world's best medical profession and related groups. The high quality of medical service to our men in the armed forces was largely dependent on that fact. From that start it is even more impressive to review the medical advances made during the war and to realize that these were the results of research. Advances in the use of whole blood and blood plasma, in the use of DDT and other chemicals in the control of insects, and of penicillin in the treatment of infections are well known. These are only a few of the advances which have been made. Many new and improved vaccines have been developed, among them vaccines against typhus, influenza and Japanese B encephalitis. New surgical techniques and materials have been de-

veloped and our knowledge of how best to use preexisting means for the prevention and treatment of disease has greatly advanced. These great advances resulted from medical research organized and geared to the needs of global warfare. No one would suggest that the same tempo should or could be continued during peacetime, but the element of coordinated attack on research problems can and must be continued.

During the past war the Committee on Medical Research of the Office of Scientific Research and Development has achieved the essential tie between fundamental research on the one hand and practical application on the other. It served as a common meeting ground for military and civilian research personnel. This is important since the committee was dominated by neither viewpoint. It thereby was possible to agree as to which projects should be carried on within the military service because of special environment, facilities, or personnel opportunities and which should be carried on by civilian agencies or in civilian institutions. There was no element of competition between the two programs but rather they complemented one another.

The general principles and policies which made the Committee on Medical Research so valuable during the past war might well be the basis for a permanent national research agency. The Medical Department is desirous of cooperating to the fullest with any gency which is established. Two points warrant mention as essentials to an effective liaison: (1) The national research agency must not interfere with the continuation of medical research within the military service, when such research can be conducted to better advantage there than elsewhere because of any one of several considerations; (2) a senior officer of the staff of the Surgeon General, United States Army, should be a member of the executive committee of the division on medical sciences of the national research agency. Only by this means can there be a proper balance between civilian and miliatry viewpoint.

In conclusion I wish to express the hope that legislation establishing a national research agency will be such that scientific personnel of the highest attainments will be attracted to and have full confidence in the agency. True research cannot be bought or regimented in peacetime.

Prepared Statement of Maj. Gen. Norman T. Kirk, Surgeon General, United States Army

It appears to be generally recognized that governmental support of scientific research is not only desirable but actually essential to the national interest. I thoroughly concur with this view and wish to emphasize that the need is no less evident in the field of medicine than in other sciences. The Secretary of War and the Director, New Developments Division, War Department, have presented the general views of the War Department at earlier hearings of these subcommittees. My comments will be confined to research as it applies to problems of military medical service. It is gratifying and reassuring to note that all bills dealing with governmental support of scientific research have assured support of a program of medical research through the designation of a separate division devoted to the medical sciences.

We as a nation can take a measure of pride and satisfaction in the quality of medical service available to the men of our armed forces during the recent war. It is appropriate to the subject under consideration to analyze the several factors

which contributed to the noteworthy results achieved in the prevention and treatment of disease and in the management of battle casualties. Unquestionably these results were due in large measure to the prewar high standards of the medical and allied professions in this country. However, it is impressive to note the agents and techniques for the prevention and treatment of disease and injuries which were not available before the war and which normally would not have been available for many years if at all. The great new developments in the use of whole blood and blood plasma, in the production and utilization of penicillin and in the application of DDT to insect control are familiar to everyone. Many other advances have been in the development of vaccines, including those against typhus, influenza, and Japanese B encephalitis; in the synthesis of the promising new drugs for the treatment of malaria; and in better methods for the treatment of battle casualties.

These were the results of research geared to the needs of global war. No one would suggest that the same tempo should or could continue during peacetime but use may be made of our experiences as to how there may be a coordinated program of medical research which is mutually beneficial to military medical service and to civil medical practice.

Medical research and in fact all research consists in part of fundamental studies and in part of studies dealing with practical application of discoveries forthcoming from fundamental studies. The great advances made during the past war stemmed almost without exception from fundamental discoveries made during the leisurely years of peace by men who could not have possibly envisioned with certainty the utility of their discoveries during our greatest crisis. This unrestricted search for knowledge must be the keystone for any national research program in the medical sciences. The practical application of discoveries is based on a recognition of need and the needs of the Medical Department of the Army are not identical with those of the civil medical profession. Soldiers at war must forsake the comparatively wholesome environment in which the American civilian lives and must exist and fight under conditions which make disease prevention and treatment doubly difficult. Moreover, no one can predict in what areas of the country a soldier must fight, or under what types of climate he must exist. Recognition of these facts brought top priority to many studies which in peacetime might have occasioned no more than indifferent interest. Further the evaluation of corrective measures under development often necessitated testing under the exact conditions which they were designed to correct, that is research within the military service. This, too, must remain an essential to an adequate and balanced medical research program. The final essential to an integrated and effective research program was provided during the recent war by the Committee on Medical Research, Office of Scientific Research and Development. This agency served as a common meeting ground for military and civilian research personnel, facilitated the expeditious completion of fundamental studies of promise, and the practical application of resulting discoveries. Requests and suggestions regarding new research could be received either from military or civilian sources and the procedures of the committee were such that the military viewpoint could be accorded proper but not unduly restrictive weight. In short, the relationship of the Medical Department to the Committee on Medical Research was such that the programs of research under each were well coordinated without either agency in any sense dominating the other. The resulting accomplishments speak for themselves.

It is not my purpose to discuss either the details or the general merits of the several bills on the subject of research now before these subcommittees. The Medical Department urgently favors the establishment of a permanent research agency with which it may cooperate to the fullest extent. There are two essentials to such cooperation:

1. Establishment of a national research agency should not be permitted to interfere with medical research normally and properly carried on by the Medical Department of the Army. The Army has in the past and intends in the future to confine its investigations largely to those problems which it can study most effectively because of the availability of special facilities or personnel and which are of direct and primary concern to the Army. This type of research should not be confused with the study of the more fundamental long-range problems from which much-needed new basic knowledge may be expected to flow.

2. Provision should be made to assure that one senior officer of the staff of the Surgeon General of the Army be included as a member on a par with all other members of the Directing Committee of the Division of Medical Sciences. This will tend to assure that the two programs of research complement rather than compete with one another.

In conclusion I wish to express my hope that legislation establishing a national research agency will be such that the agency may attract and enlist the full and confident cooperation of the wisest scientists of the country. True research cannot be registered in peacetime.

Senator MEAD. General, I believe there is unanimous opinion that the contribution made by the forces associated with you throughout the war has been highly commendable, even beyond that of our fondest hopes. I think the record in this war, as concerns your agencies, is one that you can be justly proud of. Now, you point out there that while supporting this foundation, there must be no reduction or diminution in the research work and in the authority to carry it forward. Now, lodged in your agency, do you see any possibility of duplication there that will be harmful?

General KIRK. Thank you for the remarks you made, sir, concerning the service rendered. I think what happened during the war period would answer the second question. We do not believe it would be harmful. We believe the two would well fit into each other.

Senator MEAD. Do you think the two agencies could therefore pursue a scientific investigation of a given subject, even though they were independent of each other, without doing harm to the ultimate objective?

General KIRK. Yes, sir; because one should know what the other is doing.

Senator MEAD. There would be liaison between the two?

General KIRK. Yes, sir. If there is an officer from the Surgeon General's office put on the highest staff of this agency that is made law, and he knows what is going on there, he will coordinate that Federal agency with what is being done by the Army itself. It should be to one end; one would be put in one group, to take care of their problem, the civilian, and the other would be done by the Army, as has been done so well during the last 4 years.

Senator MEAD. I think what has been done during the war is an illustration of what we can hope for if we can continue the forces with the proper coordination and the proper top-level organization.

General KIRK. That is our thought.

Senator MEAD. I thank you.

General KIRK. We think it is most important that it be continued.

TESTIMONY OF DR. DAVID D. RUTSTEIN, DEPUTY COMMISSIONER OF HEALTH, NEW YORK CITY

Senator MEAD. I thank you, and again I commend you and your agency for the wonderful work you did during the war. I had occasion to visit hospitals all over the world, and to secure first-hand information and knowledge of the work that you are doing, and it was little less than miraculous.

General KIRK. Thanks. The civilian doctors and nurses we had, from civilian life, did a grand job.

Senator MEAD. It shows they can work together on one team when they have the proper set-up.

General KIRK. Organization and administration and things to do with it.

Senator MEAD. We now have Dr. David D. Rutstein, deputy commissioner of health, New York City; Dr. Lawrence S. Kubie; Dr. Henry B. Richardson, of Cornell University; and Dr. Louis H. Weed, of the National Research Council.

Dr. Rutstein, I am awfully glad to welcome you to our committee. What about your colleagues? Have you a prepared statement?

Dr. RUTSTEIN. Yes; I have; and I realize the necessity for brevity, so I will proceed very rapidly, with the help of a few charts.

(Charts are on file with the committee.)

Dr. RUTSTEIN. There are two aspects of this legislation I should like to discuss. First, I should like to describe the need for extensive research in the fields of rheumatic fever and rheumatic heart disease. In this matter I act as a representative of the American Heart Association and the American Council on Rheumatic Fever of the American Heart Association. Second, I should like to present my views on the administrative aspects of the bill. In this I speak as deputy health commissioner of New York City in behalf of the Health Department of the City of New York.

The reason I am discussing a specific disease—rheumatic fever and rheumatic heart disease—is the fact that it is the commonest cause of mortality and disability in children and young adults.

This interest is reinforced by the fact that there has been exceptionally little financial support for research in this, one of the largest unsolved problems in public health. Legislation of the type proposed here seems to hold out the best hope for progress. I should like to present a brief description of the disease.

Rheumatic fever is a chronic disease punctuated by acute episodes of fever and inflammation of various organs of the body particularly the heart, joints, blood vessels, skin, and brain. The seriousness of the disease resides in the fact that death occurs during acute episodes and because the majority of patients who have recovered from acute attacks have permanent heart damage, so-called rheumatic heart disease.

The disease usually has its onset in early childhood, the largest number of patients having their initial attack at about the age of 8, although initial attacks not infrequently occur in adults. Attacks recur at frequent intervals, usually in late winter and early spring, until puberty is reached, at which time the attacks become less frequent. Rheumatic heart disease is the scar of acute rheumatic fever. The scar develops primarily on one of the heart valves and

causes gradual obstruction to the flow of blood through that valve and, in addition, the diffuse scarring of the heart muscle weakens that portion of the organ.

At the House of the Good Samaritan in Boston, one of the leading—out of the very few—rheumatic fever hospitals in the United States, Dr. T. Duckett Jones and associates, members of the faculty of the Harvard Medical School, made the following observations (chart): They followed 1,000 children for a period of 10 years each, following the initial diagnosis of the disease. They found that at the end of that period of time 203 were dead and 797 were living. Of those who survived 135 were so incapacitated by their disease that they were forced to lead a sedentary existence. Two hundred and nine were restricted in that they could not participate in competitive sports, and only 439 were able to lead a completely normal existence. By the nature of the disease, it is reasonable to expect that further mortality and disability would occur in the period following the first 10-year period.

In figures compiled by Dr. O. Hedley for the year 1936 in Philadelphia, the life expectancy of individuals with rheumatic fever or rheumatic heart disease was 34.8 years, in comparison to a life expectancy of 55 years for the general population for the same city.

The magnitude of the problem is great. The disease is a common one. Where surveys have been conducted, from 0.3 to 6 percent of the childhood population and from 0.6 to 1 percent of the young adult population have been found to be afflicted with rheumatic heart disease. This is similar to the prevalence of tuberculosis. Rheumatic fever and rheumatic heart disease is the commonest cause of death between the ages of 5 and 19; the second commonest cause of death in the age group 19-24 (chart). Dr. H. Swift, of the Rockefeller Institute for Medical Research, has shown that the reported deaths from rheumatic fever and rheumatic heart disease in New York City in 1938 were 1,105, as compared with a combined total of 247 for whooping cough, cerebrospinal meningitis, measles, diphtheria, scarlet fever, and infantile paralysis. In other words, in 1938 there were five times as many deaths from this one disease as from a combination of six common reportable diseases in New York City (chart).

Rheumatic fever has been a particularly prevalent disease in the military population during World War II. I discussed this matter recently with representatives of the Surgeons General of the Army and Navy and the Air Surgeon. I learned that in each of the three services thousands of cases of rheumatic fever developed, the majority of which occurred in individuals who had no history of previous attacks of rheumatic fever. This statement is not to be considered as an official one but is introduced in order to elicit the interest of the committee in this matter and to inform them that specific information can be obtained from the Offices of the Surgeons General and of the Air Surgeon.

During the past few years some information has been accumulated which has increased our knowledge of rheumatic fever. We have learned much concerning factors, which may be nonspecific, such as poverty, crowding, climate, dampness, and the detonating effect of an infection by a germ called the hemolytic streptococcus. At the present time this knowledge is not adequate to assure prevention of the disease or its specific treatment.

In view of the purposes of the bills which you are considering, it is worth noting that the funds heretofore available for research in rheumatic fever and rheumatic heart disease have been pitifully small. These funds have never been adequate to study the rheumatic fever problem in its entirety. Funds available from private sources have consisted of small grants to individual investigators. Public funds have been limited to the small amount in the budget of the Children's Bureau of the United States Department of Labor—$20,000 per State per year. These funds are allocated to the States for use almost entirely in programs of care for rheumatic patients and not for research. There is also a small amount of money utilized for research purposes by the United States Public Health Service.

During the war years the large number of cases occurring during military service among members of the armed forces required the expenditure of large sums of money, primarily for care. Dr. T. Duckett Jones, research director of the House of the Good Samaritan, can testify, if the committee so wishes, to the difficulties which are faced by investigators in the field of rheumatic disease in attempting to secure funds for such research.

Because of the importance of this problem, a conference of representatives of prominent medical organizations in the United States was called early in 1944 by the American Heart Association. At this meeting the following resolution was adopted:

> This conference is strongly in favor of the extension of public programs supported by Federal, State, and local funds for the study, prevention, and treatment of this disease. Moreover, we believe it essential that additional funds be secured from private sources for the purpose of special studies to increase basic knowledge of the disease, for professional education, and for increasing public awareness of the problem.
>
> In order to accomplish the purposes mentioned above, this conference recommends that a council on rheumatic fever be formed under the leadership of the American Heart Association and that this council shall include representatives of interested organizations.

Following the initial meeting a council on rheumatic fever of the American Heart Association was formed and includes representatives from the following organizations: The American Medical Association, the American Rheumatism Association, the American Academy of Pediatrics, the American College of Physicians, the American Public Health Association, the American Nurses' Association, the American Association of Medical Social Workers, the American Hospital Association, the National Society for Crippled Children and Adults, and the American Heart Association.

Now let us assume that a drug effective in the prevention or treatment of rheumatic fever were discovered by an investigator operating under a grant made available through such legislation as you are now considering. Such a drug should be freely available to sufferers from this disease without monopolistic restriction which might be introduced through patents.

Senator MEAD. Are there any monopolistic restrictions on the use of drugs now as a result of our patent laws? If so, what are they?

Dr. RUTSTEIN. In order to go into that point, Senator, I think I will have to cite specific instances where the existence of such restrictions may have caused death and perhaps an increase in morbidity, and I don't think I care to present that in public session. If the committee wants it, I should be glad to present it in executive session.

Senator MEAD. We will refer it to the chairman of the committee.

Dr. RUTSTEIN. I believe, further, the argument that industry will not be interested in manufacturing such a drug without exclusive rights or other protection is answered by the experience with a nonpatented drug, penicillin. I want to make it clear that I am not presenting this for the American Heart Association but for the city of New York.

Senator MEAD. When you talk about rheumatic fever and heart disease, are you talking about heart disease resulting from rheumatic fever?

Dr. RUTSTEIN. That is right, Senator.

In summarizing my first point I should like to emphasize the existence of a serious public health problem, rheumatic fever and rheumatic heart disease, which has received inadequate attention and deserves concentrated scientific effort for its solution. Furthermore, if as a result of public funds made available for research in rheumatic fever and rheumatic heart disease, scientific knowledge is attained, it should be made available to the medical profession and to the public without restriction. Now, in this organization chart I have there, I am proposing a compromise between the two positions which have been presented thus far. I have several reasons for doing this. First, because I am very strongly cognizant of the serious danger of bureaucratic control over the freedom of individual scientists: On the other hand, I know it is impossible to operate effectively from an administrative standpoint unless the delegation of authority and responsibility is clear. Moreover, I wish to emphasize that there are two aspects of the problem which are being discussed—the administrative aspect and the scientific aspect—and I think we should look to experts in both fields for advice in each of these fields and not attempt to have scientists give their opinion about administrative matters and administrators give their opinion about scientific matters. I think failure to recognize this one point has confused the entire issue. In order to illustrate this point, I should like to present an example from my experience in New York City.

One year ago the city of New York was faced with a developing epidemic of infantile paralysis. The initial effort to prepare a plan to meet this emergency was the appointment by the commissioner of health of two advisory committees, one scientific and the other administrative. The scientific committee was composed of representatives of the various scientific disciplines concerned with infantile paralysis. Representatives from the fields of virology, neurophysiology, epidemiology, pediatrics, orthopedic surgery, and physical medicine were included. This committee presented the commissioner of health with a statement which was used as the scientific basis for the management of the epidemic of infantile paralysis.

The composition of the administrative committee was quite different. It consisted of representatives actually concerned with the administrative aspects of epidemic control. It included representatives of such organizations as visiting nurse associations, medical societies, and crippled children's organizations. This committee met with the commissioner of health and formulated an administrative program based on the scientific principles enunciated by the scientific committee.

I believe that the administration of the proposed scientific agency could be effectively organized in parallel fashion. In other words, I

should like to recommend a compromise between the fear of bureaucratic domination of scientific investigation and the necessity for efficient administrative organization. I should like to submit for the record a chart showing the proposed organization.

A director appointed by the President, with the consent of the Senate, shall have responsibility and the necessary authority to properly administer the program. Two councils shall be created, the members of which are appointed by the President—one scientific and the other administrative. The scientific council shall consist of recognized leaders in various scientific disciplines. Nominations for such appointments may be made by recognized scientific societies.

The scientific council shall have two functions: First, that of an advisory council to the director on purely scientific matters. The chairman of the scientific council, with the consent of the director, shall appoint scientific subadvisory councils to advise on particular scientific problems. In the event of a major disagreement between the director and the scientific council, the latter shall have the right of appeal to the President. Secondly, the scientific council shall function as a scientific court of appeals available to any scientific investigator. Whenever an investigator determines that his freedom of scientific investigation has been abridged by alleged bureaucratic domination by the director of the foundation, he shall have the privilege of appealing to the scientific council for a hearing.

If such a hearing is granted and the charges are deemed justified, the scientific council shall so advise the director. If no satisfactory agreement is reached, an appeal may be taken by the scientific council to the President of the United States.

The administrative council shall consist of representatives of groups concerned with the administrative aspects of the foundation, such as representatives of Government, universities, science, industry, labor, and the public. The administrative council shall advise the director in the performance of his administrative functions and in the administrative planning of broad programs based on the scientific advice provided by the scientific council.

Senator Mead. Are we going to have that chart?

Dr. Rutstein. You have photostats in your report—in the report I submitted to you.

Now I want to conclude. I will just read the last two paragraphs, if I may.

Such an administrative plan provides safeguards which will permit the fulfillment of a basic principle of good administration; that is, to concentrate authority and responsibility where it can be identified. This plan also provides for the necessary safeguards against bureaucratic domination of scientific endeavor by the director of the foundation or his subordinates. The rights of appeal will serve to prevent capricious administration on the part of the director. At the same time, the appointment of the director by the President of the United States will protect the interest and welfare of the people and, in the light of atomic power, perhaps their very existence.

It is poor administrative practice to divide administrative responsibility. Such organization makes it difficult if not impossible for the administrative director to determine questions of policy. It leaves no one responsible and no one to act. It would force the director to consult individually at long distance with members of a voluntary

unpaid committee. Such hamstringing can only result in a truly bureaucratic and unwieldy organization, such as those to which Members of the Congress took strong exception in the early days of the war. The foundation must act in an efficient manner if this country is to keep pace in scientific advance with developments elsewhere. I believe that the administrative plan herein proposed will provide for such efficiency and yet assure the necessary safeguards.

Senator MEAD. You have expanded the study of the original side of this subject and brought some new and fresh information to the attention of the committee, and we appreciate it. We also appreciate your contribution with reference to this specific disease that you touched on.

You may proceed now, Dr. Richardson.

TESTIMONY OF DR. HENRY B. RICHARDSON, PHYSICIAN'S FORUM

Dr. RICHARDSON. Mr. Chairman, I am Dr. Henry B. Richardson, member of the executive committee of the Physician's Forum. I have done research in clinical medicine, on diabetes, and the glands of internal secretion. I was the director of a study on the relation of illness to family life and published an account of this last year. I am associate professor of clinical medicine at Cornell University Medical College. I am also engaged in the private practice of internal medicine and am particularly interested in the application of psychiatry to clinical medicine. I am here at the suggestion of Dr. Ernst Boas, chairman of the executive committee of the Physicians' Forum, and speak as a member of that organization.

I wish strongly to endorse the principle of financial support of research by the Federal Government, together with coordination of research activity, both governmental and private, insofar as it is aided financially by the Federal Government.

I am convinced also of the great importance of the free dissemination of scientific information which may result from the Federal support of research. Such a free exchange is indispensable for the progress of science and is in accord with its traditions.

I wish also to endorse the report by Dr. Vannevar Bush, with particular reference to the section on Fundamentals, on page 26 of that report, with the following qualifications:

In item (2) of the Fundamentals the word "citizens" should not be interpreted to exclude officials of the Federal Government or their representatives from a national science board.

In item (3) I do not see the point of excluding the Federal Government from grants. Government research is necessarily carried on at public expense. A national science board could be as useful in coordinating Government research as it could be in coordinating federally supported research by private institutions.

Otherwise the fundamentals of the Bush report, dealing with stability of funds, qualifications of administrators, contracts to organizations, decentralization of the immediate control of research projects, combination of freedom of research with responsibility to the President and the Congress, and methods for long-term financial commitments, should be regarded as axiomatic and indispensable for the proper conduct of research.

As a means of implementing the fundamentals of the Bush report, I believe that the committee print on S. 1297, offered as an amendment or substitute, is much more effective than S. 1285, as introduced by Senator Magnuson. It combines the best features of this bill and of S. 1297, introduced by Senator Kilgore. The proposal seems to me very much like the procedure which was adopted by Dr. Bush in the preparation of his report, and described in his letter of transmittal to the President. In this he says:

> Although the report which I submit herewith is my own, the facts, conclusions, and recommendations are based on the findings of the committees which have studied these questions.

In endorsing the proposals of the committee print, I wish to make a reservation in a matter of vital importance.

The provisions for secrecy affect the welfare of every citizen of the United States. Secrecy is capable of poisoning international relations and even of bringing on another war. It is also capable of throttling scientific investigation. Free exchange of information and ideas is the lifeblood of science. The advance which can be made by any one scientist, even the most original, is almost infinitesimally small. Any discovery is the culmination of work by a number of scientists all over the world. Anything which interferes with free exchange of scientific information cuts at the roots of science. It is now proposed to have such interference in time of peace, as well as in wartime. The committee proposal offers free exchange of information by one set of provisions, and takes it away by another.

If there must be secrecy, let there be as little as possible. Secrecy should be enforced, if at all, only when it is manifestly essential in the interest of national safety. Everything depends on the decision as to what is essential. The public is helpless to protect itself against secrecy, since it does not know what is being suppressed. The committee print of S. 1297, page 11, beginning with line 17, states that the President of the United States, or any person designated by him, is empowered to make this decision. The text is "any person," in the singular, not persons. I doubt if any one person, no matter who he is, should be charged with such a grave responsibility. The question is only partly military and cannot be left entirely in the hands of the military authorities. Secrecy in the interest of national defense can be interpreted to include almost anything. The need for secrecy should be determined by a board, acting in a quasi-judicial capacity, and organized in a manner appropriate for such a function. The board should be appointed by the President, and should consist of one member from the military services, one scientist, and one public member; or a multiple of these. It should be required to consult with qualified persons or agencies. A unanimous decision by all three members should be required to impose secrecy.

I should like to submit another statement on this point, but I think the burden of proof seems to be on those who say secrecy tends to national safety rather than the reverse. To get back more to my own field, anything which interferes with the tremendous change of scientific information cuts at the roots of science itself. I submit this suggestion as a possible basis for further discussion of a very important point.

Without adequate control of secrecy, the Federal support of science might be a calamity instead of a boon to the people of the United States.

As a background for my endorsement of the proposals of the committee print, I wish to state in brief the nature of scientific research. This is implied in the Bush report, but not explicitly. For a clear and forceful statement on this subject, I should like to refer the committee to the address of Dr. Alan Gregg, director, Division of Medical Science of the Rockefeller Foundation, delivered at the Conference on Medical Care, Washington, D. C., December 8, 1944.

(The report was received and filed with the committee.)

Dr. RICHARDSON. Research during the recent war was carried on by scientists who were trained before the outbreak of hostilities. Owing to the emergency, the training of young men and women for career in science has lapsed. It is necessary to make up for this depleted reserve of scientists, actual and potential, and to allow for expansion with the aid of Federal funds. Scientists with a capacity for original work are rare. As remarked by Dr. Gregg, it is extraordinarily difficult even to make an observation for which no explanation is available. To pick men who can do this is difficult, and the choice necessarily involves a large margin of error. The selection is not so much an estimate of demonstrated capacity, as a prediction of future worth. Selection can be made only by persons on the spot, who either have experience in scientific work, or are professionally engaged in promoting such work. It is necessary therefore to have a large back-log of young men and women who have the potentiality of becoming scientists.

Support of research is far from being a waste, even if it does not produce highly original work. The bulk of scientific activity goes to the confirmation of the work of previous investigators, or to the practical application of their results. Such activity has very important byproducts. It is little exaggeration to say that the standard of medical teaching or of clinical medicine in a medical school or hospital is proportional to its interest in research.

Secondary to the selection of scientists, is the choice of the field in which work should be encouraged. Most scientific progress is indirect, through contributions of a number of scientists in various fields, working in many laboratories or clinics, often in different parts of the world. The solution of the problem of cancer may become possible because some obscure scientist discovers a fact, which stimulates an idea in another scientist, who establishes another fact which, in turn, may be used to set up a scientific project by which the problem is finally solved. Progress cannot be commanded by fiat, nor can it be accelerated, merely because the subject is important, like a disease which kills or cripples a large number of people. Progress depends on being able to set up a problem, which asks a question of nature or of man. The question must be such that it can be answered by the methods which are to be used. Moreover it has to be relevant to the subject, and fundamental rather than trivial. By fundamental I mean a question the answer to which explains a large number of facts instead of only a few.

The organization contemplated in the committee print is capable of promoting research by attention to the peculiar characteristics of

scientific investigation. On page 6, lines 20 to 25, are described the qualifications of the personnel of the foundation, who are to be chosen solely on the basis of their capacity to carry out the purpose of the foundation.

Such capacity should be defined further. It demands an understanding of the nature of research and this can be acquired only by direct experience in scientific investigation or by professional activity in the promotion of research. Administrative capacity in other fields cannot of itself supply an understanding of the problems involved in research. Government participation in the National Research Foundation is desirable, but should be limited in large part to persons who have the above qualifications.

The proportion of Government members of the boards and divisions in the ratio of one to each public member is overweighted in favor of the Government. Because they are on the spot and because of their official position and experience, the Government members will carry a disproportionate weight.

The administrative set-up of the proposed foundation is next in importance to the question of secrecy. One alternative is the autonomous board of nine members who elect their own director, as proposed in the original Magnuson bill; the second is an appointed administrator who shall consult and advise with a national science board, as proposed in the Kilgore bill. The qualifications of members of the board, and their appointment by the President, are the same in both cases, but under the Magnuson bill the President has no power either to appoint or remove the director.

The proposal for an appointed administrator with an advisory committee should be adopted because:

(1) It is more in accord with recognized principles of governmental administration.

(2) It fixes responsibility on the director, who is appointed by the President. Such a director is subject, as he should be, to the pressure of public opinion of scientists, the Congress, and the public. He can be replaced if his administration does not achieve the ends contemplated by the bill.

(3) The director would be in a position to weigh the conflicting professional interests of the members of the board, and of scientists who are not directly represented by the board. Almost any scientist can be counted on to put undue emphasis on his own field of investigation. The director, through the board and the divisions, plus specialized committees which he is authorized to appoint, is in a position to redress the balance. He could, and should, act as an umpire rather than as the instrument of a majority vote.

To illustrate my last statement, I might cite the medical advisory board which contributed to the Bush report. On page 49 they describe methods for future research, which are to consist of studies of the human body and its physiological mechanism, of the nature of bacteria and viruses, and of the influence of the environment on both. They list almost all the subdivisions of medical science, with the startling exception of psychology and psychiatry. They do not mention the rapid advances made in neuropsychiatry during the war. Yet it is through this science that the most hopeful avenue exists at present for the control of chronic disease of noninfectious origin,

which is responsible for more than half of the deaths in the United States.

In this connection, it is gratifying to note that the committee print includes the social sciences as objects for Federal support.

Members of the board are not to be paid. As scientists and professional men, they are busy with other matters and would have only a limited amount of time to give to the affairs of the board. They would have time to function as advisers, but not as administrators. No nine men can be expected to operate as an administrative unit. If they are to function at all, power must gravitate to one or two men, probably to those who could spare the most time. The elected director would tend either to become a rubber stamp, or at the other extreme, to assume the prerogatives of the board. In other words, the board would have one or more local bosses who would not be officially responsible to anyone except as members of the board.

The bosses might not be identifiable, and if they were, it would take as much as 4 years to replace them in the event that the board should not function in a satisfactory manner. To replace the director, it might be necessary to replace a majority of the board. Even the President of the United States could not accelerate the process. In the meantime the Congress might revise downward its estimate of the funds necessary to carry out the act.

The autonomous board which elects a director, constitutes a form of organization which might be appropriate for a full-time salaried board which performs judicial functions, analagous to those of a court of law. It is ill adapted to executive work or administration.

In favoring a director and an advisory board, I agree with the testimony of Secretary Wallace before this committee.

The third important issue raised by the proposal for Federal aid to science is the question of patents. Provisions should be included for the control of patents, as in the committee print, on the principle that public money should be used for the public good. People should not pay excessively for the privilege of retaining their health. The patent laws are not an incentive for research in the medical field, which would be better off if these laws did not exist.

In conclusion, I wish strongly to endorse the principle of Federal aid to research, based on the fundamentals as published in the Bush report, with the qualifications which I have mentioned. I believe that the proposals of the committee print are the best implementation of these fundamentals, and that they combine the best features of the Kilgore and Magnuson bills. The most important issue raised by these proposals is secrecy in the interest of national safety, which demands especial consideration by the committee. Another highly important issue is the organization and administration on the national science board, and a third is the question of patents. With respect to both of these issues, I strongly favor the proposals in the committee print, offered as an amendment to S. 1297, introduced by Senator Kilgore.

Senator Mead. Doctor, I would like to have time to commend you in greater detail for the study you have given to the problem of organization and the question of secrecy, but time will just not permit it, so I will just say thank you for your very, very splendid statement.

Now we will pass on to Dr. Lawrence S. Kubie, of New York City. Doctor, have you a statement?

TESTIMONY OF DR. LAWRENCE S. KUBIE, NEW YORK CITY[1]

Dr. KUBIE. Senator Mead, I have a statement, but the typed manuscript is not with me, because of illness in the office. But it will be here by tomorrow. In the meantime, I think I can summarize briefly its essential contents.

Senator MEAD. Doctor, while you are talking, if I have to leave and go over to make a statement to the Senate before we hear the President, which will be at 12:30, I hope you won't be disturbed, because the whole committee will want to read your statement in the record, and the secretary of the committee will be here until the committee adjourns. We will adjourn until tomorrow, but I understand the committee rooms are taken up by someone else tomorrow, so we must get your statement today. You may proceed.

Dr. KUBIE. I will begin by mentioning the specific elements in the whole psychiatric situation which make it seem that Federal aid is of essential importance here. In the first place, research and psychiatric research reach every aspect not only of organic medicine and psychology, comparative anatomy, and embryology, but every aspect in the social and integrated human, both their organized and unorganized impact on one another, in government and in economic and in every other kind of relationship.

It is, therefore, an extraordinary all-inclusive aspect of the problem that confronts us. In spite of that fact, the survey which was made under the auspices of the National Committee of Mental Hygiene just a few years ago shows that, being very generous in its statement, the maximum investment in research in the field of psychiatry was something in the neighborhood of $350,000.

If we compare that for a moment with such things as industrial research, which in the same period was receiving $275,000,000, and general medical research from foundations upward of $5,000,000 you can see that the proportion is rather striking, psychiatry receiving, let's say—put psychiatry as the unit of 1, against medicine as 50, and industry about 2,500 times as much as psychiatry receives for research purposes.

Now, what is the actual size of the load? Our mental-hospital population, as well known, is approximately 600,000 patients at all times, with another 600,000 who are on pay roll, a total of 120,000, or about one out of a hundred of our populus. Those limited in their inherent mental capacity, in hospitals, are about 100,000 in the community, making a total in the extraordinary number of 2,500,000. In other words, 1 in 50. The psychoenurosis cases range between five and six million, according to various statements, or 1 in 25.

We come then to an actual fact, which is that about seven out of every hundred members of our population require at some time psychiatric attention from the medical profession. Against that we are faced with the equally astounding fact that our psychiatric personnel runs a little bit over one out of a hundred, one out of a hundred whereas seven out of a hundred patients present psychiatric problems, and in spite of the fact that psychiatric treatment in itself is very long and drawn out and time-consuming.

Now, in addition, we have to look at the situation in terms of the immediate problems that grow out of the war. The validity of these

[1] Dr. Kubie's prepared statement appears on page 616.

figures, by the war, is pretty well borne out by the fact that the rejection rate was approximately that, approximately one out of seven; or a total of 1,825,000 individuals rejected for neuropsychiatric reasons, and in total, about 750,000 discharged from all branches of the armed services for neuropsychiatric reasons.

We can't blink at that problem, and yet that, I am afraid, is what the medical profession, as a whole, including our medical education system, is doing, both from the point of view of training people in the field and financing research.

The problem of training psychiatrists to try to make up for this extraordinary deficit is intimately linked with research, because you can't do research unless you have men trained. Our available positions for training in the country today are about 450, of which it is generously estimated that about 50 are really first-class, of first-rate quality. We turn out in the course of the year, perhaps 50, to 75, to a hundred really competently trained psychiatrists, which is just a little over the old rate.

The problem that confronts us can only be taken care of on the basis of some broad Federal program, which includes both training and research, as the two are so closely linked together.

How we can relieve this bottleneck, particularly in the rehabilitation problem, I am afraid goes outside of the specific purpose of this meeting, but I do wish on some occasion there would be an opportunity to present worked-out plans, which various people have worked out for relieving this bottleneck, which is really the most critical manpower bottleneck problem in the country today.

I don't think I need to go into the whole question of economic loss and waste when a man becomes permanently ill for psychiatric reasons. It involves much more than is involved in most illness, in the first place, because the man survives for a long time as a dependent upon somebody. The family loses his economic support; the country loses his economic contribution; his illness in turn affects the welfare and emotional and mental welfare of his family far more intimately and directly than is true in other branches of medicine. So it becomes a nucleus from which a great many bad consequences flow.

This waste is unnecessary, in no small part, provided we could launch an adequate well-held program of training and research.

Now, I emphasize the two together repeatedly here, because of the fact that as I said, you cannot do research unless you have the manpower that is trained to do it. Furthermore, we need to recognize the fact that although the span of human life may be flowing somewhat longer, the period of training and apprenticeship also constantly flow longer. I could mention, for example, a group of students in certain postgraduate aspects of psychiatry in New York, whose average age is around 35. If we are going to have adequate training, it is obvious we must include adequate support for the men who are being trained.

We need, therefore, a program which gives us more trained men, which gives us greater coordination of the research which is being done in various parts of the country, as science is stressed throughout the country, a program which will make it possible, particularly in this field, to supply money and trained personnel to parts of the country which are particularly backward in fields of psychiatry, and where psychiatry is very much needed.

We need a program which will relieve the intense competition that exists at present both among men for posts and institutions for

funds, because this in turn leads to shortsighted research, piecework research, the research that is always aimed at a 5- or 10-year program. And these are all things which only the Federal Government and Federal resources can accomplish.

I might summarize, then, the need for Federal aid as being the cause of the increasing cost in training, because of the decreasing funds available from private sources. Federal aid is needed to stmiulate and activate work in what we might call the backward parts of the country with funds and personnel. The positive advantages, of course, from Federal aid, are the possibility for coordination and comparison of work in various centers, to insure a steady flow of knowledge gained to Federal, State, and local governments, and to military defense, where it has been proven to be so essential, to insure a steady flow of knowledge gained to industry, where psychiatry is tending to play an increasingly important role, and finally, to insure its flow to education.

That summarizes essentially what I wanted to say about the specific problem with relationship to psychiatry. I feel I would like to add a word or two in support of what Dr. Richardson said in the general nature as to the purposes of the bill as a whole. Without trying to go beyond the field of my own competence and pretending to know the final answer to many different administrative problems, I would like to say a word about secrecy, patents, and top control.

Senator MEAD. Doctor, if you will just stand by for a moment, we have Dr. Louis H. Weed, chairman of the division of medical science of the National Research Council, with us, and at first I thought I would ask to submit his report for the record, but I find that the statement is far too important, and the agency he represents is too deeply concerned, so I would like to have Dr. Weed come back again when the committee will have another sitting, and if that can be arranged, we won't put this statement in the record, but we will listen to his oral statement at that time.

You may proceed now, Doctor.

Dr. KUBIE. If my stopping at this point would enable Dr. Weed to make his testimony, I would gladly step down.

Senator MEAD. You wouldn't. You wouldn't interfere with anybody. You may proceed.

Dr. KUBIE. These three matters seem to me important because they affect the spirit in which science is carried out. That spirit is essential as we all know. Let us look to the example of our enemies for a moment, because I think they are very instructive. All who had a great deal to do with German science since the turn of the century became aware of the fact that it was a science carried on more and more behind locked doors. I don't think any of us ever worked in an American laboratory, British laboratory, for that matter, which had any locked doors, and yet the story of locked doors, men working side by side in laboratories, and adjacent halls who have no idea of what was going on behind the other man's closed doors, is a story that came back from Germany and all of us had an opportunity to see many times.

What it did to German science, I think, also is in the record and I think although secrecy, for purposes of national defense, has to be considered, it must be carefully kept in mind, secrecy can actually kill ultimate scientific spirit.

The same things, in some ways, apply to the problem of patents. We had a very interesting little example of that at Hopkins not so many years ago, in the story of adrenalin. Dr. Abel, well known and loved by everybody, had made the first basic discovery and isolation of the active principle of a gland of internal secretion.

A Japanese working in his laboratory made a slight chemical variation of Dr. Abel's discovery and patented it and that product has been sold to the public ever since.

Patents and secrecy are two things which don't mix very well with a free, active, scientific spirit, and something which we have to consider carefully in terms of this bill. It must be remembered that when science goes underground it creates anxiety. It has to be open in public if it is to allay fear and to prevent misinterpretation. This obviously does not become a complex problem of national policy, but if we feel forced to be secretive, at least we must not delude ourselves about the inevitable universal effects of a policy of secrecy.

One other point which has to do with the question of leadership in such an organization as this, the problem would not be important if it were not for the simple, obvious fact of human frailty. If human beings were not frail, it couldn't matter what kind of a top-level organization was set up, but men, including scientists, have their weaknesses, which take the form of prejudices and bias.

We have no less an authority than Claude Bernard to back us in such a statement as that, and when one stops and thinks what are the decisions that are to be made at the top level and how would bias enter into it, it seems to me it will be very often and to a very large extent in matters such as the allocation of funds. Here one gets to the question of the recognition of new fields of investigation, the courage and the ability to adventure into these new fields.

I feel strongly about this as a psychiatrist, because of the fact I mentioned at the very beginning, that psychiatry has suffered too greatly from largely unwitting prejudice and bias that color our scientific thinking, which limits itself always to the ponderable, the things which can be weighed and measured and it has, therefore, frozen psychiatry out when it comes to an adequate allocation of funds and manpower.

Now, as to how to control bias or prejudice, one never can control them, but one can balance it and one does it obviously by balancing the bias of one man against another. In the top councils, boards or commissions must represent, therefore, men with sufficiently varied backgrounds to make sure that their compromise judgments will represent a compromise between their bias, which will more or less neutralize them.

To that, one can only add one other point, which has already been so ably presented, which is the necessity for an appeal system to eliminate the possibility of an abuse of authoritative power.

Mr. TEETER. Thank you, sir. I don't want to assume the prerogative of the Senator or even the chairman, so I think perhaps the best thing we should do at this state is adjourn, and thank you all very much for your efforts.

(Whereupon, at 12:13 p. m., the committee adjourned until 10 a. m., Wednesday, October 24, 1945.)

HEARING ON SCIENCE LEGISLATION

S. 1297 and Related Bills

WEDNESDAY, OCTOBER 24, 1945

UNITED STATES SENATE,
COMMITTEE ON MILITARY AFFAIRS,
SUBCOMMITTEE ON WAR MOBILIZATION,
Washington, D. C.

The subcommittee met at 10:05 a. m., pursuant to adjournment on October 23, 1945, in room 104B, Senate Office Building, Senator Warren G. Magnuson, Washington, presiding.

Present: Senator Warren G. Magnuson, Washington.

Also present: Dr. Herbert Schimmel, chief investigator; Mr. John H. Teeter, director of hearings for Senator Magnuson.

Senator MAGNUSON. Gentlemen, I think we can proceed. I understand this morning we have very eminent representation from the biological science, and Dr. Dunn and Dr. Bronk, I believe you two have prepared statements—is that correct? I would be very glad to have you read them for the record, and if I have any questions, I might interrupt. Generally we go right ahead and hear the statement and then ask questions.

Then I understand you would like to have the other group, Drs. Stadler, Stanley, Steinbach, Waksman, Zirkle, Sinnott, and Griggs, as a panel. If you gentlemen would like to make a short statement before discussion, we would be glad to hear them, because we are trying to get a full and complete record of all the facts surrounding this problem. Dr. Dunn, if you will proceed?

TESTIMONY OF DR. L. C. DUNN, CHAIRMAN, ZOOLOGY DEPARTMENT, COLUMBIA UNIVERSITY

Dr. DUNN. I am professor of zoology at Columbia and chairman of the department of zoology there, a member of the Division of Foreign Relations of the National Research Council, and a member of the National Academy, and member of the Board of Fellowships of the Division of Biology and Agriculture of the National Research Council. The several legislative proposals for the public support of science which are now being considered are indicative of a growing realization that the advancement of science is a public responsibility. It assumes this character not merely because of the material and technical improvements made possible by science but because science is a part of all knowledge and deserves support for the same reasons that education does. Modern democracies all concede that one of the fundamental rights of the citizen is access to the best knowledge available, and scientific knowledge constitutes an increasingly large

share of the educational capital of the citizen. It is, therefore, right and wise that the State should concern itself with the discovery of new scientific knowledge and with its dissemination.

Senator MAGNUSON. May I interpose here? This is off the record.

It is also generally recognized that all applications of scientific knowledge to human welfare depend upon the soundness and the truth of the fundamental principles which are the concern of pure science. Basic research judges the importance of a discovery not by its usefulness but by its truth. This is because experience has taught us that if a new discovery is sound and true it will inevitably take its place in a system, filling in a gap connecting other known truths, so that a more complete and reasonable picture of the world will emerge to guide us in both thinking and acting.

The social need for new scientific knowledge has today become almost an emergency matter. We realize how much time was lost by our necessary preoccupation with war when pure science research in many fileds was almost at a standstill. This lost time has to be made good quickly. Moreover, it became apparent during the war how dependent science is on fundamental discoveries made in remote parts of the world and how quickly the flow of new ideas is cut off by war and isolation. We have to be sure that a maximum effort is made in our own country to stimulate the development of new basic knowledge. These considerations, coupled with the dramatic demonstration during the war of the power of publicly controlled research and development, have led to the great interest which statesmen, scientists, and the general public show in the bills now before this committee.

In offering testimony on these bills, I speak as a biologist, a research worker, who has tried to understand and assess the need of our country for basic research in biology; and to discover why it is that basic research in biology stands in such need of Government support.

When he stops to consider why there is urgent national need for biological research, the working biologist must start with the most vital fact of all, namely, our great ignorance of some of the most elementary and fundamental phenomena of life. We do not know, for example, what causes cells to divide, and this means that we do not know the causes which result in the normal growth of plants and animals and men nor the causes of abnormal growth that result in cancer and similar disease processes. We do not know the causes which operate in turning a simple cell into an embryo which develops successively the many complex parts of a human body and mind. We do not know the fundamental ways in which the light of the sun operates to produce the food and energy upon which plants, animals, and man subsist, nor indeed the basic physical and chemical mechanisms by which the functions of living bodies are carried out. We have partial knowledge and fragmentary control of some living processes; and the tremendous power gained from this partial knowledge when it is applied as it has been recently in human medicine and agriculture, to name only the chief fields of applied biology, indicates not only how valuable and socially important such knowledge is, but how dangerous it is to remain in ignorance and to fail to understand and thus to control the forces that may determine whether human societies are to be happy and prosperous or are to continue to exist on the narrow margin above misery which is the fate of most of them.

A biologist who realizes the consequences of our continued ignorance of these and a hundred other biological questions, and who knows at the same time that many of the methods and means for solving some of the fundamental problems are at hand and awaiting exploitation, will see in the proposals for the public support of basic research a great hope, an opportunity for the rejuvenation and expansion of biological science which might under proper conditions almost represent the fulfillment of his dreams.

This recognition of the need for increased support of biological research is not a new one for our Government, for one of the most successful ventures of any government into the public support of applied science has been made by the U. S. Department of Agriculture, the operations of which have served as a model for most of the other governments of the world. Beginnings have been made more recently in public medical research in the National Institute of Health and National Cancer Institute. Surely, if the fields in which the fundamental facts of biology are applied, namely, in medicine and agriculture, are recognized as public responsibilities, the support of the basic research from which sound applications arise is a matter of even greater public importance.

I should like to turn now to the second main question to which my testimony is directed, the need of basic research in biology for Government support. At present in the U. S. A. the chief additions to knowledge in the main fields of biological science—that is in anatomy, bacteriology, biochemistry, biophysics, botany, genetics, physiology, and zoology—come from the universities and colleges. Here the research work is supported largely from private sources by gifts from foundations or individuals to the private or public universities. In assessing the costs of this biological research, it is often forgotten that most research is carried on by members of the teaching staff in what is sometimes called their spare time. Actually many staff members devote themselves primarily to learning and spare an occasional period for teaching. The salaries of these research workers constitute the chief cost of biological research, and it is borne by the endowments of private universities and colleges and by the salary appropriations of the State universities. The gifts which seem to be the chief source of research funds actually provide for materials and assistants and contribute less than the salary budgets to the cost of research. Industrial laboratories constitute a very small fraction of the body of basic research in biology; and the Federal and State agencies and stations, although primarily dedicated to agriculture, do contribute some basic research.

Two things are mainly needed to expand and improve this basic research in biology. One is an assured source of supplementary funds which can be given over a period of years for specified researches in colleges, universities, and Government bureaus or experiment stations. This is needed not only for expansion but to replace the dwindling supply of private funds. Continuous and dependable support of approved research programs, which in biology must extend over a period of years, will improve the efficiency of work which is now often interrupted by the need to beg more funds from private sources. The other need is for support of institutes in which biologists can work together with, or in close contact with, the scientists whose collaboration they increasingly require: Physicists, chemists, mathematicians, stat-

isticians and others. Many biological problems turn out upon analysis to require for their solution the types of apparatus and techniques developed for physics and chemistry. For example, the biological study of the radio-active isotopes produced by the cyclotron is just beginning; while X-ray apparatus, electron microscopes, and similar costly equipment is increasingly being called for in biological research. Cooperative laboratories for scientists in these different fields would be a profitable and now even a necessary investment. These could all be carried out by the grants from the National Science Foundation.

The new trends in biological work indicate that it will be more costly in the future than it has been in the past. Many of its easy victories have been won. The hard ones lie ahead. Consequently we must anticipate a much greater scope of research and a scale of support which private donations will be unable to supply. At the same time, it is clearly in the public interest that the greater investment should be made, especially since much of the public investment will go immediately to increase the efficiency of work for which other sources have provided the plant and the personnel. The scope of the basic problems of biology clearly indicates the need for support on a national rather than a local scale. No single university laboratory, for example, should be called upon to maintain the large number of living stocks of animals and plants upon which much biological research depends. This is clearly a function for an institution which can serve the whole country. Again, many problems, especially those of animal and plant taxonomy and distribution, cannot be segregated by States or separate laboratories but call for study on a broad national front.

I would like to make a few comments on the specific bills before us.

The committee print of October 8, containing features of both the Magnuson and Kilgore bills, seems to me to provide the basic requirements for the public support of science. I should like to comment on a few organizational features of the substitute bills. To a biologist, it would seem more reasonable to have one division of basic science than to try to split off the medical sciences in a separate division. It is very difficult to draw sharp lines between medical, biological, physical, and chemical research; and it seems, at this stage of the development of science, unwise to try to segregate them. Where they use common ideas and instruments, the arrangements for support should rather facilitate cooperation than separation.

Senator MAGNUSON. Now, Doctor, right at that point, at page 4 of the committee print, section C, near the bottom of the page, we say this, and I quote the proposal:

> There shall be within the foundation a division of health and medical science, a division of basic science, a division of national defense, a division of scientific personnel education and public education, and such additional divisions, not to exceed three in number, as the Director may from time to time establish. The function of each division shall be prescribed by the Director—

And so on. Now, would that language carry out the ideas that you express in your testimony?

Dr. DUNN. Well, I think a division of basic science including medical science would express the view that I have just put forth.

Senator MAGNUSON. You will note in the committee print that we say there shall be within the foundation a division of health and medical science, and then we say a division of basic science.

Dr. DUNN. I was merely suggesting putting those in the same division.

Senator MAGNUSON. In the same division. Now, if you would give me your idea of the exact language you would prefer, I am sure we would be glad to have it.

Dr. DUNN. A division of basic science including that underlying medical research.

Senator MAGNUSON. And you would amend that portion of the bill in which we say, "There shall be within the Foundation a Division of Health and Medical Science and a Division of Basic Science," to read, "There shall be within the Foundation a Division of Basic Science, including health and medical sciences"?

Dr. DUNN. Yes.

Senator MAGNUSON. Go ahead.

Dr. DUNN. Two. I favor the type of organization in which the Director is responsible to the President, and thus to the public, rather than the one in which he is responsible to a board which has no organic connection with, or responsibility to, the public. The latter is the form of organization of the National Research Council and is appropriate for an agency with a purely advisory function but not for one with administrative or executive functions. I personally should go farther in this direction than any of the bills considered, and I have proposed that the Director should have Cabinet rank as Secretary of Scientific Research and Development. It seems to me that science is at least as important a public matter as agriculture or commerce or the post office and needs the power and responsibility attaching to Cabinet rank. It seems to me that in a democracy like ours, administration of so important a public service as the development of scientific knowledge should be responsive to public opinion and public needs and should not be isolated by placing it in the hands of a board composed exclusively of specialists whose social and political views might alone determine the direction of scientific development. As a department with Cabinet representation, scientific research would be as accessible to the effects of public opinion as are other departments of the Government, and the principle of political responsibility, which is fundamental in our system of government, would be applied to what in the future will be one of the most important functions of the Government. Moreover, the voice of the Secretary or Director of Scientific Research should be heard in the making of national and international policy, and the best way of assuring this is to have him a member of the Cabinet. Other governments have found it necessary to have a regular mechanism by which scientists can affect public policy, and we are subject to the same changed forces in the modern world as they are.

Three. In the composition of the National Science Board, I should like to register a reservation as to the wisdom of having other Government agencies represented necessarily by their heads, and to suggest that the representative of a Government agency should be chosen by the head of the agency because of his peculiar fitness to pass on matters of scientific policy. If heads are specified, this would bring at least the Secretaries of Agriculture, Commerce, and Interior into membership on a board of which the chairman has neither the power nor authority nor responsibility to match theirs; consequently decisions of the board might be unduly swayed by the influence of a strong

department and would at least be subjected to a good deal of pulling and hauling on issues which might not be concerned primarily with the advancement of science.

As a biologist who must continually consult scientific literature from other countries and in other languages, attend international congresses of biologists, and cooperate with biologists in other countries in both obtaining and furnishing facilities and materials for biological research, I should like especially to endorse paragraph C of section 8, which confers authority to cooperate in international research or development activities. As one who has labored for better facilities for exchange of publications and scientific ideas and personnel with other countries, I hope that the National Research Foundation would become the active center in promoting international scientific exchange, a function which has never been adequately served by the National Academy of Sciences or the National Research Council and has been left largely to private initiative and private funds, much of the cost being now met by the scientific investigators themselves.

Finally, as a biologist, I should like to point out that the enactment of legislation like S. 1297 will have an enormous moral effect on the thousands of research workers in the biological and in other sciences. If they can look forward to adequate and assured support of the most important fundamental research in their science, to aid in the training of young biologists and to good means for cooperating with biologists all over the world, they will become increasingly conscious of their role as public servants. The public appreciation of the value of their work will almost certainly lead to an improvement in its quality and thus of its usefulness.

Senator MAGNUSON. Now, Doctor, starting right at your last statement just what, in your opinion, would be the normal mechanics in training a biologist. Would the grants-in-aid be mainly to agricultural schools, or would they be to all types of private universities?

Dr. DUNN. I should think the grants-in-aid on some kinds of agreement or contract basis would go freely to all universities and research institutes, including Government departments.

Senator MAGNUSON. Now, going back to another subject, you strongly urge that there be some Government representation on this foundation board, and I suppose you would go further and strongly urge that the Department of Agriculture have representation on that board?

Dr. DUNN. Indeed I think it should.

Senator MAGNUSON. Now, if the board is composed, say, of 7, 9, or 11 men, whatever it may be, and part of the members of the board would be scientists, and it has been suggested part of the members of the board would be lay members, eminent citizens who might serve a useful purpose on the board, but surely, if any Government representation should be on the board, it should be someone from Agriculture, because we have made great strides, as you point out, in there.

Then supposing Congress grants this board a certain amount of money, and Congress is a little hard to get money out of occasionally, and there is just so much to go around, wouldn't you say this would lead to an overemphasis on agricultural research?

Dr. DUNN. If there is one representative from Agriculture, presenting or sitting in judgment on a proposal for a basic scientific research——

Senator MAGNUSON. There won't be over—unless you make the board so big it is unwieldy—two or three in Government representation, maybe four on the board, and surely Agriculture would be one.

Dr. DUNN. I should think so.

Senator MAGNUSON. Now, I don't say that is wrong; I am just asking your opinion.

Dr. DUNN. I think we ought to consider this, Senator: The proposals that are coming up to this board are for basic scientific research. Now this is the part of scientific research which is inadequately supported in Government, even in the Department of Agriculture, now. Most of their funds are directed toward the problems of agriculture. Now we find a proposal to investigate some problem in microorganisms, in bacteria, something of that sort which can be classied as pure science because we don't see its usefulness at the moment. That may originate with a research worker in the Department of Agriculture. He comes up to this board. You need an expert on the Board to judge the validity, how good this application is, but I think he would vote as a scientist on the merits of the proposal, rather than because he represents Agriculture.

Senator MAGNUSON. And, of course, I don't consider that these proposals in any way would interfere with the permanent workings of the research departments in Agriculture. It is our hope that we will supplement existing Government research. In other words, when, say, Agriculture has a problem in biological research, that they can't cope with within their own research departments, we hope that they would be able to come to this over-all body and say, "Here, here is something that ought to be done," and this over-all body, that may farm it out to three or four places, maybe Government institutions, or maybe a private research laboratory, or a university, or all three, or any number.

So we hope that this will supplement all existing Government research.

I notice you advocate that there should be a director, responsible to the President. You go even further and advocate a Cabinet rank, that there should be a secretary of scientific research and development, and present some good arguments as to why.

Back in the other part of your testimony, I noticed that you use as an example of why Government should undertake such a proposal as this, the National Institute of Health, the National Cancer Institute, and you quote them as successful examples. Now, their organization is entirely different, is it not?

Dr. DUNN. Yes.

Senator MAGNUSON. And isn't it correct that in setting up the Atomic Energy Commission, the proposal of organization is entirely different? In other words, don't they all follow on the same pattern, the NACA, the Atomic Energy Commission, the National Cancer Institute, and other departments of Government, or they have been set up by Congress, that deal with scientific research? They set up the board which in turn picks the administrator. Why would you make this different?

Dr. DUNN. Those deal with separate segments of a much larger problem. We are dealing here, I take it, with basic science as a whole. The others deal with individual segments and applications, not primarily with the discovery of principles. The National Institute of Health is applied in one field, cancer is applied in one field and the atomic researches were definitely limited to one field, to develop the results of basic research which had already been carried out.

I think in an organization with a spread as great as attempting to cover the whole of natural science, a public responsibility and a permanent character is imposed, which seems to me to have the same importance as any of the existing Government departments which do follow on the other pattern, namely, with a responsible cabinet officer at the head.

Senator MAGNUSON. Witness after witness here has testified that one of the prime examples of governmental aid in science to Government departments and to the public welfare in general has been the NACA. They have used that as an example of successful operation, and it covers a vast field of science. It dips into, I think, every possible field of science, because aviation is now in that position.

Would you say that that organization should be changed because it runs the whole gantlet of science?

Dr. DUNN. No. I think that organization is very good for its purpose, but we have to remember when the war came we had to bring all of these under one head, responsible to the President, which was Dr. Bush, as head of the Office of Scientific Research and Development, and not that one of the existing agencies was found to have the character and organization to serve the larger purpose which came upon us during the war, and we had to invent an organization which is more like the one described here, I think, than the organization of any of the existing agencies.

Senator MAGNUSON. Your thought on the matter, then, in recommending this type of organization, is that here we are dealing with a different application of Government aid for science and scientific research than we are in these other agencies I mentioned?

Dr. DUNN. I think, Senator, this is a wholly new department.

Senator MAGNUSON. What about the atomic energy department? Won't that run the gantlet of all science and everything else before we are through?

Dr. DUNN. Yes.

Senator MAGNUSON. That was set up differently, was it not?

Dr. DUNN. It all headed up in OSRD.

Senator MAGNUSON. I am speaking of the new program, whereby Congress set up an organization to control all aspects of atomic energy. It seems to me that will run much further afield than what we propose here in the realm of science.

Dr. DUNN. Has it been adopted?

Senator MAGNUSON. No; but all the proposals—there is no suggestion made for a single director or man to handle it. It is suggested that a board be composed and the composite thought of the board would prevail.

Dr. DUNN. I don't wish to be misunderstood on my views of the board and director. The board is certainly a very important part of any organization which will have appropriating powers and supervision, and have to give judgment over these very wide areas.

Senator MAGNUSON. The opposition that has been suggested here by many of the witnesses to an organization such as suggested by you has been by men who are eminent scientists, who feel that this board might become merely advisory, and that, in the ordinary workings of such organization, it would not attract men of high competence to come here and act in advisory capacity. They would merely say, "Oh, well, it is being run by, say, the Director, what good is my advice down there."

Dr. DUNN. Again, Senator——

Senator MAGNUSON. Or you mention the OSRD. Of course, under the spur of war you can get all scientists. They came and gave freely of their time and their money and did their duty, but the thought has been expressed that in peacetime it may not work that way.

Do you think there is any grounds for such fear, or do you think this advisory board could function as well as it functioned under the OSRD?

Dr. DUNN. I think we have other examples of scientists who give their time gladly to the National Research Council, which is composed of voluntary members who come to Washington and serve the purposes of the National Research Council, and I think there is a great honor that scientists feel in attaching themselves directly to the public service in that way and the closer the body is attached to the public service, I think, the better response you will get from scientists.

Senator MAGNUSON. But that organization is the reverse, too. It is set up as a board.

Dr. DUNN. I merely quote it as an example of the willingness of scientists to cooperate.

Senator MAGNUSON. You see, in this suggestion, I don't say it is right or wrong, we depart by way of organization from all other experience we have had in organizing Government aid to scientific research.

We have always set up the board, composed of the men who are eminent in the field, and representatives of Government agencies and then they have appointed their administrator. In this case we are departing——

Dr. DUNN. But we are following an older pattern of Government, which is recognized in these great departments which have been doing scientific work for the Government for a long time; that is, within the Government departments. So we have really two patterns, and I prefer the more inclusive one. I think it may be a matter of public responsibility, and the reason why I would prefer vesting the power in a man to be appointed responsible to the President, is that he could be brought to account by the public more responsibly that way than if he is only accountable to a board which has no organic connection with the public.

Senator MAGNUSON. Well, of course, none of these proposals suggests that the President should not have free authority to appoint the board and that the board should be responsible directly only to the President of the United States.

Dr. DUNN. Of course, they are on a per diem allowance, not Government employees, and their attachments to this board——

Senator MAGNUSON. I agree with you. They would be much more independent than a man appointed by the President.

Dr. DUNN. And when you are going to spend a large sum of money, the limits of their independence should be very definitely defined. I would be afraid of some political influence in the board itself, which should be moderated by a director, who acts as chairman of that board.

Senator MAGNUSON. Do you concede that the major parts of the decisions to be made in such a foundation will be scientific decisions or administrative?

Dr. DUNN. Chiefly administrative in the top boards. Most of the scientific decisions will be made by the investigators themselves, who will do the scientific work.

Senator MAGNUSON. Or the panels underneath?

Dr. DUNN. Even further down. By the scientists in the colleges and research institutes who are applying for the funds and have their proposals judged by the committee divisions, by the division committees, and then the committee division decisions are reviewed and approved or disapproved by the board as a whole.

Senator MAGNUSON. Of course, I am inclined to agree with you if we are going to adopt the one-man responsibility, that we would be much better off in having him have Cabinet rank than just to be a Government director. Now, let me ask you one more question on organization. It has been suggested—I forget who the witnesses were—that the members of the so-called Board be regularly paid Government employees. What have you to say about that?

Dr. DUNN. No; I would rather not see that. If you have a director who does carry that responsibility, that is, if he is employed directly by the Government and his responsibility is to the public. I think he should stand for the board in that responsible position.

Senator MAGNUSON. Now there is just one more question. I wanted to ask you, no I think you covered that. I was going to ask you on all these matters you spoke about, whether or not the foundation would serve the purpose and I believe you finally have come to that point in your statement, that it could when you are dealing with scholarships and the development of basic research in biological work.

Dr. Bronk, we will be glad to hear from you.

TESTIMONY OF DR. D. W. BRONK, DIRECTOR, JOHNSON RESEARCH FOUNDATION, UNIVERSITY OF PENNSYLVANIA

Dr. BRONK. During the war I have served as Coordinator of Research in the Office of the Air Surgeon at the Headquarters of the Army Air Forces and as Chief of the Division of Aviation Medicine in the Office of Scientific Research and Development. I have also continued to act during this period as director of the Johnson Research Foundation of the University of Pennsylvania, an organization which has been engaged in research on many biological problems for the armed forces. I presume I have been asked to discuss the proposed bills because of these experiences. I would also like to speak as a biologist and a physicist concerned with the influence of modern technology on human welfare. At the outset, I would like to say that I believe the authors of these bills which provide for the Federal support of scientific research have faced a challenge which our country dares not evade. Science has gradually freed men from the hazards of

ignorance and from the uncontrolled domination of natural forces, but science and technology have also created a complex civilization that severely taxes the biological capacities of the individual citizen. Each new scientific discovery that has provided men with new powers has created new problems and new dangers. We cannot now retreat out of the scientific civilization we have created, and we cannot stand still. Either we will increase our understanding of the forces which shape our lives and use them to our advantage, or we shall fall victims to uncomprehended and uncontrolled powers—of which atomic energy is but one example.

If there is any field of activity which is the proper province of the National Government, it is the encouragement of research. For it is from scientific research that our citizens have the greatest promise of higher standards of living, better health, and security against the dangers of foreign agression. Individuals, unaided, cannot cope with these problems.

After a war in which we have been forced to destroy vast quantities of our natural resources, it is well to give thought to the future sources of national strength. Fortunately, our greatest national resource is one that need have no limits. I refer to our knowledge of the physical universe, our knowledge of plant and animal life, knowledge of the workings of our own bodies in health and disease. Such knowledge is a resource which can be increased indefinitely for the common good. Unfortunately, it can be lost through indifference and neglect. Accordingly, thoughtful citizens should derive confidence from the determination of Congress to insure the vigorous development of scientific research, so as to increase our national welfare and to prepare ourselves for the unforeseen problems of the future.

The basic biological sciences have an important role in this program. It is from the investigations of the biologists that we derive our knowledge of plant and animal life and human behavior. Accordingly, it is a science of primary importance in all matters of human welfare. Agricultural science is the application of biological discoveries. Medical science is the application of biological knowledge in the cure and prevention of disease. Engineering and technology are useful only insofar as they serve the biological function of satisfying the physiological requirements of human life. It is indeed difficult to deal with any aspect of science or human activity without reference to biological considerations.

As a biologist who has worked for 20 years in the field of medical science, I would strongly urge recognition of the fact that medical progress depends upon free and undirected research in general biology. Our knowledge of nutrition, of infectious diseases, of human parasites, of vision, of nervous diseases, of growth, and of heredity has come in large measure from biological research that originally was not directed toward specific medical problems. Furthermore, many of our most distinguished contributors to medical science have not been trained in medicine and have not worked in medical laboratories. These are facts which are widely recognized by the medical profession. I stress them here only to emphasize the desirability of providing in the proposed legislation for adqeuate support and sympathetic consideration of basic research in biology. I do not believe it should be treated as a science subsidiary to medicine, for it is the more inclusive of the two.

Senator MAGNUSON. Right there, Doctor, would the amendment suggested by Dr. Dunn satisfy the contention you make there?

Dr. BRONK. Completely, sir.

Senator MAGNUSON. Let me read the language suggested by him again, so it will be clear. That would leave the section to read, if your suggestion was followed out, that—

There shall be within the Foundation a Division of Basic Science including health and medical science.

Dr. BRONK. No. I would not include health and medical science in a Division of Basic Sciences. I would prefer an arrangement similar to that in S. 1297 of October 8.

Senator MAGNUSON. You are reading the committee print?

Dr. BRONK. Yes. On page 4, lines 18 and 19:

There shall be within the Foundation a Division of Health and Medical Science, a Division of Basic Sciences.

Senator MAGNUSON. I see. You just reverse it. Is that correct?

Dr. BRONK. Yes, sir. I think there would be a confusion of functions if we were to include medical science with basic science, because they are directed to somewhat different objectives and follow different methods of procedure.

Senator MAGNUSON. Go ahead, Doctor.

Dr. BRONK. Nor do I think it is a wise emphasis to provide for the creation of a Division of Medical Research without corresponding specific provision for biology as one of the fundamental sciences.

Mr. Senator, there is one other field of practical human usefulness—other than agriculture—in which biologists play an important part. I refer to technology. The function of the machines and the instruments and the machine-made environments of our industry is to satisfy biological requirements. Our industrial products increase our muscular power to perform work. Or they increase the range of our senses. They increase the speed with which we can move. And they protect us against our environment.

Unfortunately, many of these developments have been made without regard for the biological characteristics and needs of those for whom they have been constructed. Biological knowledge has been too little used in the direction of our machine civilization, and this has been to our disadvantage.

To meet the stresses of machine war our Army and Navy adopted a more wholesome attitude. Biologists were employed in such establishments as the Armored Force Medical Laboratory, the Naval Medical Research Institute, and the Aeromedical Laboratory at Wright Field to guide the design of weapons, so that they would best satisfy the biological requirements of the fighter. Biologists designed equipment to supply the necessary amount of oxygen to maintain the consciousness of our flyers on high altitude bombing missions, and suits to prevent black-out during aerial combat maneuvers. Biologists and anthropologists specified the dimensions of ball turrets and seats so that they could be small but useful. Psychological biologists selected the men for our Air Forces and determined the duty for which they were best fitted; thus they saved millions of hours of training time and countless casualties. Biologists taught our airmen how to survive their unnatural duties in an unnatural environment. These jobs were done by men trained in the basic biological sciences. They applied knowledge which had been gained from research undertaken

without regard for its ultimate usefulness. Their accomplishments now suggest an important role for biological science in making our technological civilization more suitable for human life.

The cooperation of biologists and physicists that made such a program successful is an example of the advantages that come from the pooling of scientific disciplines, and the dissolution of boundaries between sciences. Accordingly, I favor the creation of a single Division of Basic Sciences as provided in bill S. 1297.

I believe the first and most important step in the further development of our scientific research is the training of more able men and women for teaching and research—in all areas of the country, not a few isolated centers. Bills S. 1297 and S. 1285 will meet this requirement by fulfilling three important functions.

The provision of funds for fellowships and scholarships should make possible the better training of more able scientists, without regard for family fortunes. During the past 3 years I have spent considerable time in Europe, especially in Russia, France, Belgium, and England. In those countries I have heard, over and over again, the statement that one of the most important requirements for their future welfare is the training of young scientists, and that this is a responsibility of the state. In all those countries they were formulating plans for sending abroad their more able men, so as to increase the scientific potential of the nation.

A serious deterrent in recruiting able men and women for a career of research has been the unpromising and uncertain economic status of the scientist. In industry the research laboratory has often been the first to feel the pruning knife of depression; in universities research is usually the part-time avocation of an over worked teacher. Everywhere the scientist is notoriously underpaid. I have recently had evidence on this point, for I have been endeavoring to secure positions for biologists who have served during the war as commissioned officers in the Army Air Forces. The usual salary offered these men who have had 3 years' service in military teaching and research, 2 years of prior academic experience, and 8 years of university training is not more than $3,000.

The salary scale is especially low in the biological sciences. Chemistry is valued as the source of new wealth, and physics as the creator of magic devices which make men more powerful or give them pleasure and comfort. But fundamental biology which merely seeks the why and how of nature is seldom recognized as the source from which agriculture and medicine derive their power to feed the Nation and make us healthy. Accordingly, financial support is relatively meager. By increasing the funds available for research, the proposed legislation would improve the salary scale of scientists and thus recruit more able men for basic research.

In one other respect there is need for governmental action to safeguard our supply of trained scientific personnel. I refer to the tragic misuse of such personnel by governmental agencies, and the refusal to permit the training of replacements. I should have thought that there had been enough discussion of our deplorable policies in this regard, but my experiences of recent months indicate that important military and civilian officials have not yet learned that a trained scientist is rare and has a social value. It would be futile to discuss, at this time, the reasons for our errors; we shall probably not make

the same mistakes again. But it is pertinent to suggest that a division of scientific personnel and education, or some similar agency, should have the prestige and authority to conserve, in the interest of the Nation, this important human resource.

If we are to train more scientific workers, we must find more financial means for their subsequent employment. It is my opinion that funds from many sources are desirable, in order to insure freedom for exploration of new fields, just as the privately endowed college is an important factor in the healthy development of education. But others, more familiar with this problem than I, have testified to the inadequacy of diverse private sources. Certainly the support of research, which benefits every aspect of our national life, is a proper function of the Government.

The Government has always concerned itself with the development, and protection for the future, of basic natural resources such as forests, water power, soil, and fisheries. It has not been primarily concerned with their immediate conversion into lumber products, industrial manufactures, and food. Basic research is not unlike such resources, for it provides new scientific knowledge of future value for our national welfare. In our system of economy, private initiative is more likely to apply new knowledge to a useful end than it is to foster the original exploration. Many see the desirability of applying a new discovery in the development of materials, machines, or weapons, in the treatment of disease or in the improvement of agriculture. Few have the wisdom or the faith to finance abstract research, in the exploration of the unknown, for the benefit of future generations.

I do not wish to imply that the Federal Government should refrain from the support of applied research directed to a very specific objective. In many instances such support will be necessary if the application is ever to be made. Nor do I wish to imply any sharp distinction between basic and applied research. What I wish to stress is that which has been emphasized many times before in the course of these hearings: future scientific developments of value for the welfare and security of the Nation require the present support of research in the physical and biological sciences, even though it appears to have not the least practical usefulness.

This is an especial concern of biologists for it is our primary function to lay the foundations for later progress in medicine, in agriculture, and in industry. Under the stress of solving urgent problems during the war years biologists have permitted large areas of their science to grow barren of new ideas. We must replenish our scientific capital if we wish future dividends from the applied sciences.

Because of these considerations, I believe it is essential that there be created a Division of Basic or Natural Sciences for the encouragement of research of a purely exploratory nature, uninhibited by the necessity for solving useful problems. I am convinced that the most far-reaching and revolutionary discoveries would result from the activities of such a division.

The healthy development of science in our country requires the maintenance of favorable working conditions for our scientists. In this regard the proposed bills carry inherent dangers as well as great benefits. The scope and magnitude of the undertaking is so great that the legislation may alter the character and trends of scientific

research for generations. We must, therefore, guarantee the preservation of conditions necessary for the healthy development of science.

The most important condition for effective research is freedom for the scientist to follow paths suggested by his curiosity or unexpectedly revealed by his experiments.

In the application of previous discoveries, the organization and direction of effort by a central agency can expedite the achievement of a useful end. Research accomplishments of the Army, the Navy, and the OSRD have proved this. Furthermore, discoveries of general significance in other fields are often made in the course of such directed work.

But scientific discovery is the exploration of the unknown, and I, for one, do not see how it is possible to direct an explorer through unknown territory. Because of this, I urge that means be found for giving many scientists of proven or potential competence the freedom to direct the course of their own investigations.

Frankly, I doubt whether first-rate scientists will work under any other conditions except for the occasional challenge of a patriotic or humane motive. Even in Russia, where direction of private life is not unheard of, I found that most of the scientists were quite free to plan the course of their own research. I dare say the Russian Government has learned that this is the most productive method of direction.

Here, too, it is well to bear in mind that many of the most important scientific discoveries seemed, at the time, to possess little human value. Faraday's experiments on electromagnetic induction were thus questioned, but they made possible the electrical industry of today. Pasteur's discoveries were denounced. The significance of our own Willard Gibbs' pioneer work in physical chemistry was recognized by few.

Such reflections lead me to prefer a central administrative organization in which authority for action would be vested in more than one individual. I would hope, furthermore, that the board charged with the administration and allotment of funds would consist primarily, but not exclusively, of scientists who had an intimate familiarity with the methods and objectives of research. I would strongly favor the utilization, whenever possible, of established organizations of scientists, such as the National Academy of Sciences and the National Research Council, whose members are chosen on the basis of their scientific competence. Finally, I would urge that provision be made for placing some funds in the hands of such bodies, for the support of promising research disregarded by the central governmental agency. Only by relying on such a diversity of judgments and by operating through such a multiplicity of directive channels, do I believe we can insure the necessary freedom for scientific exploration.

Because our work often seems to be far removed from practical application to human affairs, these are problems of especial interest to those of us who are biologists. Much of our research will be understood and fairly assessed only by those who are themselves trained in biology. Such a training will usually be necessary to recognize in the biological research of today values that are no less than the value of Mendel's abstract studies for modern agriculture, or of Pasteur's work for the control of disease, and of Paul Bert's investigations of oxygen lack, 75 years ago, for the high altitude bombing operations of our Eighth Air Force.

I stress the necessity for setting up adequate safeguards against the control of research by scientifically incompetent administrators because I have frequently encountered the unfortunate and wasteful consequences of such control during the war. I do not think we can dismiss this as an improbable danger. And I can see no more justification for the direction of scientific research by men untrained in research than for the interpretation of our laws by a Supreme Court composed of scientists. The one is as ridiculous and as dangerous as the other.

Finally, and in summary, I would like to reaffirm my conviction that biological research offers great potential benefits to the citizens of our country. It is, therefore, desirable that those men and women who wish to give their lives in this form of public service should be provided with financial assistance during their long years of training, and with adequate employment subsequent thereto.

I strongly urge that funds for the support of research be made available to scientists through the medium of organizations, such as the National Academy of Sciences, which they themselves have established for the advancement of their science. If, in addition, it is deemed wise to create a National Research Foundation, as I think it is, I believe its successful operation will require that it be administered by a group of the most competent scientists in the country.

A Division of Basic Sciences within the framework of that foundation would be essential for the vigorous furtherance of biology and its sister sciences of physics and chemistry and mathematics.

Provision should also be made for the application of biological knowledge developed under this Division to the practical problems confronting a Division of Medical Research and a Division of National Defense.

Lastly, I would urge consideration of a suggestion, made to me by Professor Redfield of Harvard University, for the creation of an additional Division of Natural Resources. Such a Division would provide a valuable outlet for the biological sciences in adding to our national wealth. The future prosperity, health, and security of the country depend upon our material resources; through science these resources can be conserved and developed, and made more abundant for the demand of a higher standard of living and a larger population.

Senator MAGNUSON. Dr. Bronk, I am somewhat struck with your last suggestion there. In drawing bills, you know, it is pretty hard to remember everything. Sometimes the English language is not adequate to cover everything in a legislative way, but it does seem to me that that suggestion would be a valuable one, bearing in mind our interpretation of what this Foundation would do, in that it would supplement other agencies of government.

Couldn't, well, such a Division help out, say, the Department of Interior, in the national park system, conservation of certain resources forestry, which sometimes doesn't have its own adequate research departments—all these things that pertain to our natural resources? They sometimes become political footballs, rather than purely conservation and scientific matter.

I wonder if the Division of Natural Resources couldn't help the Bureau of Fisheries in wildlife and plans of that type.

Dr. BRONK. Very much so. As I see the organization, we should have a broad Division of Basic Science, which would discover new

knowledge, provide new ideas. Then we should have divisions directed to specific practical ends of national importance. Medicine is certainly one. National defense is another. A Division of Natural Resources would reach into another vast area of human usefulness. These divisions of applied sciences would translate the findings of the workers under the Division of Basic Sciences into practical usefulness.

Senator MAGNUSON. It would definitely fit within the concept of our Government to step in and take a hand on the conservation of natural resources, which has been a long-established precedent in our Government.

Dr. GRIGGS. Mr. Senator, might I interrupt at this point? I wish that the committee would call the director, the Chief of the Fish and Wildlife Service, on that point. I talked with him, Dr. Gabrielson—I shouldn't quote him for the record, because he would testify in his own report—but he expressed to me the difficulty he has in obtaining support for just those things which such a division would take up.

Senator MAGNUSON. I think you are quite right. I am very familiar with Dr. Gabrielson's appearances before the congressional Appropriations Committee. It is a struggle to squeeze out something that might react to really genuine conservation of our fish and wildlife. In fact, the arguments usually become much more economic than scientific, and much more political than scientific.

Now, Dr. Bronk, you have recently returned, haven't you, from Russia, from a scientific expedition there?

Dr. BRONK. That is true.

Senator MAGNUSON. How do they handle it in Russia?

Dr. BRONK. In Russia funds are given to the Russian Academy of Science.

Senator MAGNUSON. Which is a body?

Dr. BRONK. Which is a body similar to the National Academy of Sciences in this country. I don't say the bookkeeping and administration is done by the Academy of Sciences in the U. S. S. R., but the information I had—I must admit it was second hand—was that the direction of research in the U. S. S. R. was largely done by the Academy of Sciences. I asked specifically, for instance, "Suppose you wanted to set up a new type of laboratory?"

They said, "It would be considered by the appropriation division of the Academy. They would then make proposals to the Government and submit a budget. They would then go out and see about the staffing of the division." Perhaps Professor Dunn could give more information on that than I. He is intimately familiar with those problems too.

Mr. DUNN. Yes; I am sure Dr. Bronk is quite right. The only exception would be in comparing the Academy of Science of the Union of Soviet Socialist Republics with our own. I believe the academy in the Soviet Union is an operating organization, while ours is not. Ours is an honorary body, Senator.

Senator MAGNUSON. Chartered by Congress.

Mr. DUNN. Yes.

Dr. BRONK. The difference is that the National Academy of Sciences in this country has not had adequate funds to exert an influence similar to that of the Russian Academy.

Senator MAGNUSON. Dr. Bronk, you stress what many other witnesses have stressed, that basic research should be free at all times. Now, under the provision of this bill which would establish scholarships and grants-in-aid to nonprofit universities and other educational institutions, do you think that the language is sufficient to insure free study and free scientific research?

Dr. BRONK. I do.

Senator MAGNUSON. In that particular instance I am talking about?

Dr. BRONK. I do say satisfactory; I feel the more channels you can give for appraising a given proposal, the safer you are. Even scientists may be very conservative about encouraging others in the development of new lines of research. I think it is necessary to guarantee to people coming along with new ideas a fair hearing and I would hesitate to see the determination as to whether a new idea should be given a trial put in the hands of just a few individuals.

We still have our private support of research, and I would hope the Rockefeller Foundation, the Carnegie Foundation, and others would still be in a position to take up some proposals disregarded by the National Foundation, but I think it would be also appropriate for the foundation to give to an agency such as the National Academy of Sciences some unearmarked funds for them to dispose of in supporting research which might fall between the cracks of this proposal.

Senator MAGNUSON. Your idea is a lot like Senator Kilgore's and my idea, that this foundation would be able to either make a grant-in-aid to the Carnegie Institute or ask them to go ahead with a problem, or the Carnegie Institute could come in and say, "We have a problem we can't solve. Farm it out some place," for, as you gentlemen so well know, science knows no geography. You might find it in the most isolated place. You might find it with one individual, or you might find it with an institution with very few students and very little laboratory equipment, but they would be free, under this proposed language we are trying to draw up, to go ahead any place they saw fit.

But your thought is, as I catch it, that, in order to have that wide spread, have aid to free, basic scientific research, the ideas must also come from many sources, and the suggestion——

Dr. BRONK. Very definitely.

Senator MAGNUSON. Rather than from maybe too few individuals. Otherwise you concentrate that, such as other things are concentrated.

Now, another section I wanted to ask you about here. You make a suggestion that there should be a division of scientific personnel education. That is now included in the bill. Does that language satisfy your suggestion?

Dr. BRONK. Very satisfactorily.

Senator MAGNUSON. I would like to get clear, and I am sure Congress would like to get clear this completely. May I also interpose here off the record?

(Off the record.)

Senator MAGNUSON. Now, let's see if we can get this straight. Maybe the panel can help out. We want the language right here.

Dr. Dunn suggests that the language should read: "There shall be within the foundation a division of basic science, including health and medical science"; and Dr. Bronk suggests that "There should be within the Foundation a Division of Health and Medical Science, including a division of basic science."

Dr. BRONK. In addition to a Division of Basic Sciences.

Senator MAGNUSON. In addition to. That sounds like tweedledum and tweedledee to me, but there probably is a difference, or the two of you wouldn't have different ideas.

Dr. DUNN. I don't think our opinions are so different. I think we are both most anxious to stress the reservation of funds for this exploratory work under pure science. Now, if that is to be whittled down by setting up a division of medical science, to which some guaranteed fraction of the funds will be appropriated, we are to some extent inverting the pyramid. We suppose these applied sciences rest upon the pure ones and we want to make sure there is a sufficient reservation of support for the pure science, so they shall not be crowded out by the applied ones, Senator.

Senator MAGNUSON. At least the position of all you gentlemen is that we should be sure in writing this bill that the position of basic science should have its proper importance in the bill. I think we can agree on some language to that effect.

Dr. BRONK. I think to insure that, it is highly desirable that there be a division of basic science, in addition to the division of medical science and national defense, Senator.

Senator MAGNUSON. In other words, you would just add and's in there, so there would be no question about the fact that basic and health and medical science might get mixed up by somebody in the future interpreting the language.

Dr. BRONK. I think on page 4, S. 1297, committee print, it is worded adequately.

Senator MAGNUSON. And would make it a little better.

Dr. BRONK. I would begin with a division of basic sciences—because the work of such a division will be the foundation for the work of the other divisions—a division of medical research; a division of national defense; etc.," but their order is a mere detail.

Senator MAGNUSON. Sometimes interpretation of legislation years later becomes quite an important detail. Now, you also mention another thing that interests me, in which you say the Government has concerned itself with the development and protection of future basic national research, primarily concerned with the immediate conversion of lumber products, food, and so forth, and basic research is not unlike such researches. I am wondering if it is the opinion of you gentlemen here that the Government should do more in its application to other basic research than purely agriculture. Of course, that is a pretty broad term, but we have set up, for instance, and we have in the new appropriation bill coming up, five or six lumber research laboratories, such Government research institutions as that.

I am wondering if you think we should set up more of those as Government research institutions or pass such a bill as this and allow this foundation to supplement these organizations with various problems and farm them out maybe to private institutions, but correlate the whole thing, if our objective would not be better served by that, or whether we should just enlarge the strictly pure governmental institutions?

Dr. BRONK. I would follow the latter of the two courses you suggested, set up such a foundation as this and see where you go from there and how far you could operate under the framework of the proposed legislation.

Senator MAGNUSON. I don't mean to interfere with what they are now doing. We should be of great aid to them, all these various Government laboratories, but probably we might be just as great an aid, if the foundation could take and organize research for them, that they could use or anyone else could use.

Dr. BRONK. Certainly you could be uncovering new scientific knowledge, which would be of inestimable value to the regional laboratories in carrying out their missions. From the regional laboratories and similar organizations you would gain information to the nature of practical problems that wanted solution in terms of more fundamental research.

Senator MAGNUSON. Now, there has been suggested a section for the international development and exchange of scientific information.

I suspect that you gentlemen are more interested in that than any other group, because of the necessity of biological science, particularly in the most important phases of it, to know what other countries are doing and what they have developed and I am wondering if that meets with your wholehearted approval. That would be official, by the way.

Many of you go as private individuals or representing private institutions to scientific congresses, but we thought the Government could take some official notice and in some cases pay the expenses if the board decided it was necessary.

Dr. BRONK. I think it is a wise provision. I believe it covers the necessity adequately. I, indeed, for a long time have been convinced of the desirability of creating within the State Department scientific attachés to some of the more important foreign countries. Such men could well be scientists of great distinction, who had passed the peak of their scientific activity, or indeed had become professors emeriti, and would be in a very valuable position to keep us informed of what was going on in those countries and to be very desirable ambassadors to the cultural life of other countries.

Senator MAGNUSON. That is a new idea. I had not thought of that. At least you would suggest in such countries as England, Russia—I suppose even German science will come back some day; you can't knock science out of the heads of German scientists—but at least in those countries that have scientific programs, this country having no so-called intelligence, relying on the embassies to give us information, which sometimes goes to the State Department; that is as far as it gets; but that a scientific attaché would be just as valuable as a military attaché in your opinion?

Dr. BRONK. More so and more easily acceptable.

Senator MAGNUSON. Let me say we are just discussing this now. Anything you want to suggest or anything else, go right ahead. I just wanted one more question of Dr. Bronk. I wonder if you could enlarge on your statement. I refer to the tragic misuse of such personnel which Government agencies condone in the refusal to permit the training of replacement. We would like to know about that up here and correct it if we can.

Dr. BRONK. I was afraid you might. That was the reason I didn't enlarge on it. I think, Mr. Senator, the lack of regard for the proper use, development and conservation of scientific personnel is a very serious indictment against our Selective Service Act. I fully realize the difficulties they have operated under. I fully realize it is

difficult for a local board to defer Mrs. Jones' son, a scientist, and take Mrs. Smith's son, a lawyer, but after all, we have been fighting a technological war, and the chances of Mrs. Smith's son coming home alive very frequently depend on the activities of Mrs. Jones' son in the laboratory. It is hard to get that over to a local board.

Senator MAGNUSON. It is a matter of usefulness; in an integrated, comprehensive war effort, usefulness to the country can assume various degrees of aid to that war effort.

(Off the record.)

Now, Dr. Sinnott, I understand you have no prepared statement. If you would like to say something for the record, we would be glad to hear you. Dr. Stadler has a statement, which we will be glad to hear.

Dr. SINNOTT. Since there are here six or seven members of the panel who have something to say, I can boil down the statement to a considerable degree.

Senator MAGNUSON. Whatever you wish.

TESTIMONY OF DR. EDMUND W. SINNOTT, STERLING PROFESSOR OF BOTANY AND DIRECTOR OF THE SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY

Dr. SINNOTT. I am Dr. Edmund W. Sinnott, professor of botany at Yale, director of the Sheffield Scientific School at Yale University. My brief statement to submit for the record is concerned primarily with the importance of plant research, which is often overlooked. Much of the work today is concerned with animals, but there is a great deal of evidence that work with plants is fully as fundamental. Plants have, we might say, the basic patents for many processes that go on in living things.

I want to say that personally I am very strongly in favor of considering biology as a separate, independent discipline from the physical sciences and medical sciences, and I hope very much that it will be set apart either as a division under the basic sciences division, or certainly not as a subsidiary in any way to medicine. Of course, it touches upon physics and chemistry and medicine, but the biological sciences should be recognized as independent entities.

I would like also to enter for the record, a vote of the faculty of Sheffield Scientific School at Yale, taken the other day, recommending four general principles for the legislation which we are considering. I won't read these to you, except to state them as follows: (1) The importance of complete freedom for research. (2) The body responsible for the administration of Federal support should be completely free from political control and should select its own executive officer. Men chosen should be of highest scientific reputation. It is desirable that the National Academy of Sciences, which was established to advise the Government on scientific matters, should present in nomination a panel of names from which the members of the administrative body would be appointed. That is what Dr. Bronk and others have suggested. (3) Provision should be made, as often pointed out today, for the support of the most fundamental and theoretical scientific investigations, as well as for the development and application. (4) The importance of fellowships supported by Government funds under graduate scholarships and postgraduate fellowships should not be overlooked.

Those four points, in their opinion, would be the most important ones to incorporate in this general legislation. I will submit this statement for the record.

Senator MAGNUSON. I would like to put your whole statement in the record, if you don't mind.

Dr. SINNOTT. Yes, sir.

Science today is no mere accessory of civilization but is an essential element in the life of everyone. Not only are the applications of scientific research important but the fundamental and theoretical studies on which these are based. In the program for Government support of research it is therefore essential that such fundamental work be given primary consideration.

I wish particularly to advocate support for the biological sciences, the sciences of life. Physics, chemistry, and their applications are for various reasons especially conspicuous today but we should not forget that the most important problems, since man is a living being, are those which are concerned with life. Many of these problems, such as those concerned with nutrition, heredity, and the essential changes which go on in living substance can be studied not only in man but at almost any level in the plant and animal kingdoms. Discoveries of the utmost value in medicine and nutrition have been made with molds, and in heredity with peas and fruitflies. The deep questions of food, health, sex, race, and even of philosophy are in the last analysis biological problems.

The relation to man of research on animals is obvious, but the importance of studies on plants is too often overlooked. Plants make the fundamental chemical unions. They hold, so to speak, the basic patents on which not only the food supply of the world but all other products of living things are made. For example, by the use of the green pigment chlorophyll, plants can unite carbon dioxide and water to form sugar which is the final source of starch and thus of the chief energy foods of man as well as many raw materials. We cannot yet duplicate this process in the laboratory.

Plants also are the ultimate source of proteins, made by the addition of nitrogen to sugars or similar substances. Thus all milk, meat and eggs, and the living substances of our bodies came originally from plants. Very simple plants as well as large ones are important here. Thus yeasts have recently been found to produce great amounts of protein, for stock feed, from molasses and distillery wastes. Some bacteria can take nitrogen directly from the air and thus make proteins.

Most of the vitamins as well, including all the B group, are made in plants. Plants as well as animals need vitamins and some of the most important discoveries on vitamin nutrition have been made with plants.

Plants produce many healing substances, most conspicuous of which today is penicillin, formed by a simple mold. Many other similar substances are now known to be made by plants.

In industry the story is much the same. Hosts of products like wood, fibers, and rubber are made by plants; and, perhaps even more important in this day of synthetic chemistry, the simple compounds which the chemist uses come from plants. Give a chemist sugar or starch or cellulose and he can make almost anything under the sun, but only plants can make these necessary simple compounds.

Plants, either living or from past ages, as in coal and petroleum,

yield about nine-tenths of our power. This is simply sun energy locked up by green plants in their tissues.

The practical importance of plant biology is therefore obvious. It should be remembered that in all these fields there are a host of problems demanding active research and research directed not only at problems of immediate practical importance but at the underlying processes of plant life. Plants are remarkable physical and chemical machines, and we are only just beginning to gain an understanding of what makes them run. Some of the most important scientific discoveries of the future will doubtless be made by biologists who are probing into the secrets of plant activity. The results of such research will not only contribute to man's economic welfare but—and this is perhaps even more important—they will give us a clearer insight into the mysterious processes of life itself.

These discoveries are as likely so be made by an investigator who makes purely scientific studies on plants as by one who is looking particularly for practical results. These studies touch biophysics, biochemistry, mathematics, and other sciences; they necessarily are related to medicine and the affairs of man, but they are part of that great general program of biology, which deals with all the sciences of life and which is sharply distinct from the physical sciences on the one hand, and medicine on the other.

In any legislation embodying proposals for Federal support of science I therefore feel it is very important that biology be set up as an independent subject of research. Unless this is done, we shall be in grave danger of limiting the support of a field which in the next few decades should be productive of discoveries more significant for the life of man than those in any other branch of science.

The board of permanent officers of the Sheffield Scientific School of Yale University, at a meeting on October 8, 1945, unanimously approved the report of a committee appointed to formulate policy as to Federal support of scientific research.

This report recommends the incorporation of four general principles in any legislation concerned with the problem. These are as follows:

First, there should be complete freedom of research, both as to choice of problems and methods of attacking them, on the part of individuals and institutions. No hampering restrictions of any kind should be attached to grants of funds nor should there be attempts by any supervisory agency to regiment scientists to to control the direction of their research. Voluntary cooperation is to be encouraged, and ample support should be given investigators whose studies do not fit into any preconceived program.

Second, the body responsible for the administration of Federal support should be completely free from political control and should select its own executive officer. Men chosen for this task should be of the highest scientific reputation and enjoy the confidence of scientists generally. It is desirable that the National Academy of Sciences, which was established to advise the Government of scientific matters, should present in nomination a panel of names from which the members of the administrative body would be appointed.

Third, provision should be made for the support of the most fundamental and theoretical scientific investigations, most of which have no obvious practical application. Popular interest and support will naturally center on problems which promise immediately useful returns, but great care should be taken that fundamental problems,

always the ultimate source of knowledge upon which applications must be based, are not neglected.

Fourth, since the almost complete cessation of education in science during the war has resulted in a serious deficit in trained scientific personnel in this country, it is important to increase substantially the number of persons receiving such training. This can be done by establishing, through Federal funds, a series of undergraduate scholarships, graduate fellowships, and postdoctoral fellowships in the sciences. Compulsory enrollment in a National Science Reserve should not be a stipulation for such support.

Senator MAGNUSON. Now, Doctor, in the last paragraph of your prepared statement, you present the two original bills, as to the provisions made for basic research and biology. Let me ask you the same question I asked the others: Would the revised bill, committee print, satisfy the suggestions?

Dr. SINNOTT. I think it would. The division of basic science, I should be inclined to put first on the list.

Senator MAGNUSON. I think we can work out some language on this. It is a question of language, but we are all in accord, I think, on the idea. We will put this whole statement into the record, and I want to ask you one question. Could not the setting up of such a foundation be of great aid, say, to such an institution as you are connected with, in the very work you are doing?

Dr. SINNOTT. Very markedly. We are very heartily in sympathy with the whole idea, because the one thing we need desparately, as Dr. Dunn and Dr. Bronk pointed out, is more support for fundamental research. Our men are overworked in many respects, and when they come to their hours of research, they find very often they haven't the apparatus, technical assistance, and support that money can bring, and we are very heartily in sympathy with the whole idea.

Senator MAGNUSON. Does the Department of Agriculture, the Research Division—and I ask this merely for information—in any way subsidize such a division as you head?

Dr. SINNOTT. No, not in any sense.

Senator MAGNUSON. The liaison there is one of exchange of information and ideas, is that correct?

Dr. SINNOTT. That is correct.

Senator MAGNUSON. Well, supposing you hit upon an idea that might require the use of such facilities as do not exist in your university, with members of your own field, of source. Do you take that to the Department of Agriculture, Research Division, and tell them to go on further with it?

Dr. SINNOTT. No; there is no relation of that sort.

Senator MAGNUSON. But such a foundation as this could integrate and correlate all that?

Dr. SINNOTT. Yes. It would be a very useful service.

Senator MAGNUSON. All right, Dr. Stadler, if you wish, we would be glad to hear from you.

TESTIMONY OF DR. L. J. STADLER, PROFESSOR OF FIELD CROPS, UNIVERSITY OF MISSOURI; AGENT, UNITED STATES DEPARTMENT OF AGRICULTURE

Dr. STADLER. I should like to summarize my prepared statement very briefly in order to leave time for the statements of the other

members of the panel. However, some of my colleagues on the panel have asked that I attempt to discuss the development of hybrid corn, if time permits, since that is a striking recent example of the application of basic science to the national welfare, and an accomplishment which would hardly have been possible without a system of public support of scientific development.

Hybrid corn is a new type of corn which has come into extensive use only in the last few years.

Senator MAGNUSON. Is that Wallace's corn?

Dr. STADLER. Yes; some people call it Wallace's corn. I should add that the work Mr. Wallace did in the early development of the possibilities, before they were widely appreciated, has been a very real element in the development of corn to its present state. The corn we have in mind 12 years ago was still an experimental curiosity. In 1944, 75 percent of our total crop was hybrid corn, and this year, though the precise figure cannot yet be set, the proportion is still higher. In the most productive corn-growing regions of the United States, the proportion of hybrid corn grown is now close to 100 percent.

The increased efficiency in food production, which resulted from the use of hybrid corn, was an important item in our wartime economy. The money value of the increased harvest during the 4 war years, over what would have been produced by the same land and labor without the use of hybrid corn, is conservatively estimated at $2,000,000,000. The annual return in future years, from this one application of basic science to the improvement of a single crop plant, is much more than the amount now proposed for the Federal support of all scientific research.

The point I want to bring out is simply that this corn was the result of investigations designed with no consideration of the improvement of crop plants. Their purpose was a scientific analysis of the degeneration which commonly follows the mating of close relatives, that is, the genetic effects of inbreeding. This problem was of significance in human heredity, in livestock improvement, and in the general theory of organic evolution, as well as in plant breeding.

Senator MAGNUSON. You bring out here a very potent and applicable instance whereby a proposal such as this could take effect, had it been in existence years ago; is that correct?

Dr. STADLER. I don't understand your question.

Senator MAGNUSON. I say, you point out a very good instance here showing, should we have had in existence such a foundation as is proposed here back those years ago, in the development of say, just hybrid corn alone, we would be further advanced with it.

Dr. STADLER. No, Senator, my point is not precisely that. I am pointing to an example we happened to find in the basic research of the time, not stimulated by such a foundation, which has been used in application, to the extent and value I have here indicated. The hope of the establishment of a foundation is mainly in the contribution it would make to a greater number of such discoveries, fit for application in applied sciences.

Senator MAGNUSON. The point being, similar instances such as the hybrid corn case would crop up and be developed, and they could take hold of them and see that they moved along some place.

Dr. STADLER. Precisely.

Senator MAGNUSON. Go ahead, Doctor.

Dr. STADLER. In any sudden great expansion of material support for science, there are dangers of defeating the major purpose, for our intellectual resources cannot be suddenly expanded to the same degree. An appropriation of $100,000,000 per year for a new superinstitute of scientific research might conceivably set back scientific discovery for years. I believe that the method proposed for applying Government support through contracts with established institutions minimizes this difficulty, and that with wise administration this support may lead to a significant acceleration in our scientific advance. The provision for scholarships and fellowships is an indispensable part of the program.

The chief suggestion I would make in reference to the text of the bills applies to both S. 1285 and S. 1297. Both bills are intended to provide greatly increased support for basic science, and in this respect I think they mark a new departure in Government policy in relation to the support of science. We have had large appropriations for science before, but always for science directed toward a rather specific objective—for agriculture, for the geological survey, for conservation, for national defense, and so on. The new departure is in the attempt which these bills propose, to promote the advance of basic science. This grows out of our belated recognition of the fact that basic science is the goose that lays these golden eggs. In the example I described, the development of hybrid corn, the Department of Agriculture was able by the investment of about $5,000,000 to secure a return in billions. But this return was made possible not only by the $5,000,000 worth of made-to-order research, but by a discovery in basic science which was wholly incidental and which could not have been made to order. The same is true in practically every case of great practical returns from scientific development. The germ of the development was some discovery made in the course of an investigation designed for the broadening and deepening of knowledge, without regard to any application which could be seen in advance. If the history of science in relation to human welfare has taught us anything, it is that these are the studies which ultimately have the greatest practical value.

To insure, as far as may be possible in advance, that this objective will be central in the administration of the foundation, and particularly in the judgments that will be passed upon it annually by appropriation committees and budget officials, I think the founding act should be made more explicit in regard to pure science. I think it should state as the major purpose of the foundation the advancement of human knowledge and understanding, and that it should provide for a division of basic science specifically charged with this responsibility.

The remaining paragraphs were written before I saw the revised committee print. I should like to add a brief comment on consideration of the committee print. I should like to say, from the standpoint of the furtherance of basic science research, which, I think, most scientists will agree is the core of the problem, the evolution of the proposed legislation through the course of these hearings is somewhat disturbing. The rough statement of a stable budget originally proposed in the Bush report amounted to 122½ million dollars, including 20 million for each of the fields of applied sciences, medical research and national defense, 50 million for natural science, in which most of the basic work would be done, and 32½ million for education and other nonresearch activities.

Of the two bills offered to activate these proposals, S. 1285 made no provision for a definite ratio between the amounts to be expended for various purposes, while S. 1297 provided that not less than 20 percent of the funds appropriated for research and development should be expended for research and development in each of the applied-science fields—one, national defense and security; two, health and medicine. These minimal figures were substantially in agreement with the expenditures estimated in the Bush report. In subsequent discussion of functions of the foundation, many important functions have been suggested additional to those originally proposed. One of these is the inclusion of social sciences, and social science would alone represent a very large increase in the activities of the foundation. I am strongly in favor of the inclusion of the social sciences, and I recognize that there are many other ways in which the activities of the foundation might be expanded with national benefit, but it must be recognized, if the minimum percentages for defense and medicine are maintained, then all expansion in research and development must be at the expense from which basic science must be fully supported, for the added activity can be provided only by reducing those allotted for basic research, or proportionately increasing the total allotment.

The proposed revision of S. 1285, committee print, of October 12, makes the situation even more difficult, for it adds the provision of minimum percentages for defense and medicine and changes the basis of determining these percentages from total appropriation for research and development to the total for all purposes. Thus, all activities in education and scientific collaboration, including the proposed large expenditures for scholarships and fellowships must be financed from the residue.

The effect of expanded research activities of the Foundation, whether in research or otherwise, upon the support of basic science research, is thus intensified.

Senator MAGNUSON. Of course, Doctor, you raise a problem that is an eternal legislative problem. As I understand your statement, you first suggest that we make certain the division or allocation of the funds as between the sciences.

Then you also say if we make certain on another phase of that, then these groups will be naturally let out, or they won't get sufficient funds. As I say, it is an eternal legislative problem. Some of us have come to the conclusion that we had better delegate the authority of allocation to a group of people who know more about it than we do, and I am wondering if probably you couldn't come to that conclusion too, by the very evidence you give, which shows how difficult it is to make a definite allocation. The military, of course, are going to insist on a minimum amount for military research, and I would think that the temper of Congress right now would be to grant that minimum amount. I am sure there will be some Senators who will want to increase it. But I am wondering if we wouldn't be better off leaving the allocations to a body who we hope knows more about it than we do.

Dr. DUNN. Provided there is a strong statement of the purpose of the action, which will guide the board in making the allocations. If you take Dr. Stadler's suggestion; namely, the purpose of the act is to increase human knowledge and basic research in the natural and social sciences and make it the dominant purpose of the act. Then you insure that the board will be instructed thereby.

Senator MAGNUSON. Wouldn't that be accomplished, Doctor, by insuring that one of the main purposes of this act—there would be no question regarding the intention of Congress—would be for the establishment of scholarships in basic research?

Dr. STADLER. Yes; my purpose in making these suggestions was merely to make the act more explicit with regard to the importance, not primarily of scholarships and fellowships, but of basic research itself, that is, of research in which the criterion is the value and significance of knowledge obtained, rather than the use to which that knowledge can be put as we see it in advance.

I think nothing more will be required than to see that that statement is explicit and emphasizes that point, and second, the establishment of a division of basic research which is charged with the accomplishment of that purpose.

Senator MAGNUSON. Your point is that at least we could guide the policy of the board and administrator to the board, or both, by setting forth our intention that one of the primary purposes of the act was to foster basic research.

Dr. STADLER. I have no expectation that the administrator would need any such guidance, but I feel that in his struggle to maintain a balance between the kinds of activities which the foundation will be doing, he would be strongly supported in maintaining the appropriations for work of the foundation.

Senator MAGNUSON. There is also some merit to that because funds for applied research problems can be obtained from the Congress through the various departments themselves. The War Department can say—well, the atomic bomb is an example of it. And even Agriculture can do that. I am sure you hit upon a point. It is the intention of all of us who have been thinking about this problem that we do exactly what you suggest, but it is very difficult sometimes to put it down in black and white.

Dr. STADLER. I am certain that it is difficult, and I am not at all sure that anything would be gained by attempting to remove the present stipulated minimum for military and medical research. I only want to stress the point that those factors do put a definite ceiling upon the various worth-while activities upon which the foundation can embark, and in considering any one of these proposals, we have to consider not only what it is worth, but what is the basic science which will be sacrificed to pay for it.

Senator MAGNUSON. Let me ask you this, too. Do you think that it is all the more important now, due to the fact there has been a twilight zone in the development not only of basic science, but basic scientists, due to the war, and that time is of the essence to get that back? We probably won't catch up again for 10 years on that, unless we do something like this.

Dr. Stadler, we will put your entire statement in the record at this point.

PREPARED STATEMENT OF DR. L. J. STADLER, PROFESSOR OF FIELD CROPS, UNIVERSITY OF MISSOURI; AGENT, UNITED STATES DEPARTMENT OF AGRICULTURE

My testimony will be concerned chiefly with the value to the national welfare of basic research in biology, outside the field of medicine. This can be discussed most concretely in terms of actual examples from our own national experience.

In my discussion I shall refer in some detail to the development and use of hybrid corn, since this is a striking recent example of the application of basic science to the national welfare and an accomplishment which would hardly have been possible without a system of public support of scientific development.

Hybrid corn is a new kind of corn which has come into extensive use only in the last few years. Twelve years ago it was still an experimental curiosity. In 1944 75 percent of our total crop was hybrid corn; and this year, though the precise figure cannot yet be set, the proportion is still higher. In the most productive corn-growing regions of the United States, the proportion of hybrid corn grown is now close to 100 percent.

During the 3 war years for which final data are now at hand, 1942–44, we grew the three largest corn crops in our history. The crop was 15 percent greater than that of the 3 years 1917–19, and it was produced on an acreage smaller by 10 percent. This increased yield per acre, which was largely due to the use of hybrid corn, was a very significant item in the wartime economy. Without it, we should have had to make a large increase in the manpower and equipment allotted to food production, or we should have had to get along with much less food.

The increase in national corn production due to the use of hybrid corn may be estimated fairly closely. We know from the crop estimates of the United States Department of Agriculture what fraction of the corn planted in each county was planted from hybrid seed, and we know from numerous and widely distributed field experiments the comparative performance of different strains of corn when grown side by side under identical conditions. In these experiments, adapted hybrids consistently outyield the varieties of corn formerly grown, with an average margin of more than 25 percent.

This is an increase in yield which costs nothing except the added cost of producing the special type of seed and the added cost of harvesting the larger crop. In practice the seed is commonly produced by specialized seed growers, and the production and sale of hybrid seed corn has now become an industry with an annual turn-over of about $75,000,000.

A conservative estimate of the increase in national corn production during the four war years 1942–45, due to the partial use of hybrid corn, is 1,800,000,000 bushels. The money value of this increase, on the basis of the farm price per bushel, is more than $2.000,000,000.

It is, therefore, no exaggeration to say, speaking in terms of the over-all national economy, that the dividend on our research investment in hybrid corn, during the war years alone, was enough to pay the money cost of the development of the atomic bomb.

This dividend will, of course, continue and will be increased as further research improves upon the present hybrids. But allowing for no further improvement, the return from this one application of science to the improvement of a single crop plant will amount each year to far more than the annual budget now proposed for the Federal support of scientific research.

Hybrid corn had its beginning in the experiments of two young American geneticists, G. H. Shull and E. M. East, beginning about 1905. These experiments were designed with no consideration of the improvement of crop plants. Their purpose was the scientific analysis of the degeneration which commonly follows the mating of close relatives; that is, the genetic effects of inbreeding. This problem is of significance in human heredity, in livestock improvement, and in the general theory of organic evolution, as well as in plant breeding.

Both investigators used corn as experimental material, not because of the economic value of the plant but because of its unique technical advantages for the study of inbreeding. A corn plant is both male and female. By applying the pollen to the ear of the same plant, it is possible to produce a large family of seeds whose mother and father are the same individual.

This is the closest possible inbreeding, and it may be continued generation after generation so long as the inbred strains are able to survive. The problem could have been studied as well with guinea pigs, or fruitflies, or Jimson weeds, so far as these forms are technically suitable, and all of these forms have been used by other students of the same problem.

A byproduct of these experiments was the discovery that hybrids between the inbred strains of corn were in some cases more productive than the original corn before inbreeding began. Each combination between two of these elementary strains produced a uniform first-generation hybrid stock of distinctive character. Shull pointed out in 1910 the possibility of developing a practical method of corn breeding on the basis of this new principle.

Scientific corn breeding by more direct methods had been going on for a long time before this. A great variety of methods for improving the yield and quality of corn had been applied, some with considerable success. But improvement in the yield of well-adapted varieties appeared to have reached its ceiling, and with the development of more accurate methods of yield testing about 1915–20, agronomists convinced themselves that none of the breeding methods then in use were capable of producing enough improvement in yield to permit experimental demonstration.

Shull's method was not ready for practical application until some technical modifications had been made. These were developed during the next 10 years. By 1920 it was clear that a comprehensive program of corn breeding by crossing inbred lines offered the promise of substantial improvement in the yield of corn. This program, however, would have to be an elaborate one, far beyond the scope of a single experiment such as that which Shull had conducted. The method owed its success not to the mere process of inbreeding and crossing, but rather to the opportunity which this gave to select the better and reject the poorer among the elements of the original mixture. Hybrids among the inbred lines may be good, bad, or indifferent, depending upon what heredity the particular lines used bring into the combination.

The problem, then, was to produce large numbers of inbred lines from varieties adapted to the various corn-growing regions and to evaluate them, not in terms of their own characteristics but in terms of what each could contribute to the value of its hybrids in combination with any of the other lines. This involves comparison not only in yield, under widely varying conditions, but in factors of quality, resistance to specific diseases and insects, and other features determining the value of the crop. The number of possible hybrid combinations among 100 lines is about 5,000, and the number of ways in which these may be combined in double crosses (the form in which they are used by the farmer) is many millions. Obviously, only a minute fraction of these can be tested or even observed, and difficult problems of method must be solved to develop an efficient procedure.

About 1920 the United States Department of Agriculture undertook the development of a comprehensive program for the application of Shull's method to the practical improvement of corn. The work was organized in cooperation with the agricultural experiment stations of the leading corn-growing States. This program, which is still in operation, is in many ways a model of effective development of a scientific principle for the national welfare. By 1934 corn hybrids of established superiority were ready for distribution in practical quantities. In that year they occupied a small fraction of 1 percent of the national acreage. Their value, in the judgment of farmers, is attested by the rapid advance of that percentage to its present level. The total expenditure for corn breeding by the Federal Department and the State experiment stations, through the entire 25-year period 1920–45, was in the neighborhood of $5,000,000. The returns on this investment I have already indicated.

Hybrid corn is of course only one of various examples that could be mentioned, though a particularly striking one because the returns have begun to come in in impressive fashion. There are various developments from which comparable advances may be expected in the future. As an example of these, I may mention the application of endocrine physiology to animal husbandry. Endocrine physiology is a branch of biology which deals with the functions of the glands of internal secretion. These glands profoundly affect the metabolism and the behavior of the animal, through the effect of minute quantities of certain substances which they produce, called hormones. In recent years the increasing knowledge of these hormones and of the glands which produce them has led to great advances in human medicine.

The milk production of a cow, the egg production of a hen, and the meat production of a steer are all vital phenomena of the kind that we should expect to be greatly influenced by the action of these hormones. From the standpoint of the dairy farmer, the cow is a machine for converting feed into milk. Some cows are much more efficient machines than others, and these differences turn out to be largely differences in endocrine activity and balance. To a large extent endocrine deficiencies may be corrected by the administration of hormone preparations or of crude extracts of the glands and in some cases by the simple feeding of gland substance or of synthetic substitutes. The analysis of the hormone effects is a very complex problem, but the work has now gone far enough to give assurance of far-reaching practical significance to agriculture.

Now the point I want particularly to emphasize is this: The limiting factor in scientific development for the common welfare is the supply of basic knowledge from which this development proceeds. When the basic knowledge of heredity

had gone as far as it has gone by 1910, a wise administrator of a public research establishment could see that here was a method which offered great possibilities of development; when it had reached the stage of 1920, he could see the approximate cost and the approximate return for a definite program of planned research. It was then possible to invest about $5,000,000 with fair assurance of an ultimate return in billions. But this was not possible in 1900. In 1900 the basic knowledge did not exist.

Essentially, the case is similar in almost every instance of scientific development, whether in agriculture, in industry, in medicine, or in war. The development consists in the application of some bit of scientific knowledge to a practical problem. The application may require a far greater volume of scientific work than the original discovery, and the scientific work required may be work of the highest quality. But this may all be planned and more or less made to order. The original discovery, on which the whole development rests, cannot be made to order. We could not, in the First World War, have developed the atomic bomb no matter how much money was appropriated or how completely the scientific resources of the Nation were devoted to the problem. The possibilities of applied research, tremendous though they are, are entirely within the limits of our basic scientific knowledge at the time.

It is the great merit of S. 1285 and S. 1297 that they provide for the support of basic science research on a scale comparable with that proposed for applied research.

In any sudden great expansion of material support for science, there are dangers of defeating the major purpose, for our intellectual resources cannot be suddenly expanded to the same degree. An appropriation of $100,000,000 per year for a new superinstitute of scientific research might conceivably set back scientific discovery for years. I believe that the method proposed for applying Government support through contracts with established institutions minimizes this difficulty and that with wise administration this support may lead to a significant acceleration in our scientific advance. The provision for scholarships and fellowships is an indispensable part of the program.

I believe that both bills might be strengthened by a more explicit statement of the responsibility of the foundation to advance those investigations designed for the broadening and deepening of knowledge without regard to the applications which may be seen in advance. If the history of science in relation to human welfare has taught us anything, it is that these are the studies which ultimately yield the greatest returns in practical value.

The hard common sense of appropriation committees will, perhaps always, insure a steady drift of publicly supported science toward the more immediately practical. In this lies the chief danger that public efforts to promote science may retard the advance they are designed to further. This is the reason for the apprehension with which many scientists view the increase of governmental support of science. I am not so skeptical of democracy as to think that society is incapable of providing intelligently for its own interest. I think the public will support pure science when it is brought to see the value of pure science, just as it supports liberal education when it is brought to see the value of liberal education.

I do not think the remedy for the situation is to provide a special buffer for the protection of science from the dangers of public support—and I am very dubious that the proposed controlling board could accomplish this in any case. The remedy is rather to meet the issue squarely—to apply scientific method at its best and to defend it on the ground of its demonstrated social value.

For this reason I would urge that the founding act state as a major purpose of the foundation the advancement of human knowledge and understanding, and provide a division of basic science charged with this specific responsibility.

An important difference between these two bills is in the provision made for basic research in biology. S. 1285 provides for research in the biological sciences as part of the responsibility of the division of medical research. The division established for research additional to that conducted for the purposes of medicine and of national defense is limited to the fields of the mathematical and physical science. S. 1297 provides for research in the basic sciences in addition to research in the fields of national defense and of medicine and health, without specifying what sciences are to be considered basic. In this respect I think the provisions of the latter bill are much the better, for tney leave the foundation free to further basic research in any field in proportion as it finds such research of significance. There is no reason to expect that the needs of basic research in biology would be covered by the activities of a division of medical research, just as there is no reason to expect that the needs of basic research in the physical sciences would be covered by the activities of a division of national defense. A division having as

its sole objective the advancement of basic science is the instrument upon which we could most confidently rely to enlarge the store of scientific knowledge which is the source of all future scientific development. In my opinion, it would be a grave error to limit the scope of such a division to any segment of the general field of science.

Senator MAGNUSON. Dr. Stanley, we will be glad to hear from you.

Dr. STANLEY. I have a prepared statement, but because of the time factor I prefer to summarize it.

TESTIMONY OF DR. W. M. STANLEY, MEMBER OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON, N. J.

Dr. STANLEY. I am a member of the Rockefeller Institute for Medical Research, at Princeton, N. J., although I am appearing as an individual scientist. With respect to the present legislation, I am inclined to believe the central authority in any program of support should be vested in a group, rather than in a single director. This is, of course one of the controversial points.

The National Academy of Sciences was established by act of Congress as the official advisory body to the Government in scientific matters, and I believe that full use of the Academy should be made in this proposed legislation. I believe the advice of the Academy should be sought not only in connection with the controversial issues that have arisen in connection with the proposed legislation but also in connection with the scientific appointments relating to the central authority of the foundation.

I am inclined to favor S. 1285, relating to the composition of the board, because it is proposed to vest the power of the National Research Foundation in a board rather than in a single director. However, I believe six members of this board should be scientists, appointed by the President, after receiving recommendations from the National Academy of Sciences, with three members being distinguished lay citizens appointed by the President.

With respect to the discussion which has been going on regarding the division of funds, I would favor the elemination of these minimum requirements, for the very reason that you can't foretell where the emphasis should lie in the future. I favor just eliminating all minimum requirements. If we should get the Utopia of our dreams, we might not need, for example, to spend 20 percent of the funds in national defense, although, as you have indicated, that the achievement of that utopia will probably be very difficult.

I think I am in general agreement with the provisions of S. 1297 relating to the use and dissemination of the research findings. I once thought that the patent problem had no place in this proposed legislation because it appeared separable, and I thought it should be subjected to a separate study.

However, the earlier testimony, especially that of Secretary Wallace, indicates that such a study is in progress, and that the provisions of S. 1297 would in no way interfere with that study. I think, therefore, that care should be taken to insure the complete and free dissemination of information.

Senator MAGNUSON. Wallace is having a study made of our patent system, for the purpose of giving it a thorough reexamination, which probably would be taken up by the Patents Committees of Congress. But in the meantime, if this bill should pass, don't you think it is

desirable to have some patent features in the bill, to protect the Government's interests, if there were grants for scholarships to private institutions—that there should be some language to protect the Government's interests? Go ahead, Doctor. I note in your statement regarding personnel and make-up of the board—we can discuss that, whether or not that is advisable. You suggest there should be a portion of the board made up of scientists and a portion of lay members. Do I interpret you to be opposed to Government representation on the board?

Dr. STANLEY. On the top board?

Senator MAGNUSON. On the top board?

Dr. STANLEY. Yes. There should be agency representation. I think that should come at the lower level, in the divisions.

Senator MAGNUSON. You think it should come in the so-called divisions that are set up?

Dr. STANLEY. Yes.

Senator MAGNUSON. I also want to put your full statement in the record, with your permission.

Dr. STANLEY. Yes, sir.

PREPARED STATEMENT OF DR. W. M. STANLEY, MEMBER OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON, N. J.

I am a member of the Rockefeller Institute for Medical Research at Princeton, N. J., although I am appearing as an individual scientist. During the past 3 years I have been conducting research work as a responsible investigator for the Committee on Medical Research of the Office of Scientific Research and Development. This research work has had to do with the development of vaccines against certain virus diseases, some of which were mentioned by General Kirk yesterday. During the 10 years preceding the war I was engaged in fundamental research work on plant viruses. I can assure you that my earlier experience in fundamental research made it far easier to attack the problems that arose with the war.

I think that Dr. Dunn, Dr. Bronk, and the other members of this panel have explained in a vivid manner the great contributions that biology has given to society and have stressed adequately the great need for additional support of the biological sciences. The Bush report and part II of the report on findings and recommendations of Report No. 5 from the Subcommittee on War Mobilization to the Senate Military Affairs Committee provide powerful and convincing arguments that the Federal Government should, by legislation, provide for the support of scientific research and the development of scientific talent in American youth. I am in complete accord with these two basic ideas. During the war the mobilization and utilization of scientists for a common cause took place on an unprecedented scale. In general, scientists were not only willing but eager to leave the research work in which they were interested and to undertake work of importance in the effective prosecution of the war. However, the very great success that has been achieved should not lead one to believe that similar successes will automatically accompany such a mobilization of scientists during times of peace. I think that there is a burning desire on the part of most scientists to return once again to their own research programs, research programs which, in general, have provided in the past the great discoveries which have formed the foundation upon which much of our wartime research has been built. During the years preceding the war scientists operated quite effectively in our universities and other nonprofit research organizations and in industry.

However, there has been an unfortunate tendency, especially in recent years, to divert research personnel from university research laboratories to industrial research laboratories. Furthermore, we have not made it possible for all of the scientifically inclined youth of this country to initiate and to continue their training in science. We have, during the war, even prevented them from engaging in scientific training. We have, therefore, not utilized to the fullest extent this

great natural resource. For this reason I think that the scholarship and fellowship aspects of the proposed legislation are of the greatest importance. It should be made possible for every individual in the Nation to continue scientific studies and scientific research in war as in peace, so long as that individual continues to excel. If the means for making this possible are provided, this should eventually result in a tremendous increase in the number of scientists in this country. Because of financial limitations, it seems unlikely that our universities and nonprofit research organizations will be able to provide research opportunities for many of these newly trained scientists. For this reason, it seems likely that additional financial support will have to be provided. Although it would be highly desirable to have this support provided by private means, it nevertheless appears somewhat unlikely that additional support can be provided by private means. One is driven to the conclusion, therefore, that this financial support must be provided from Federal funds. Insofar as the immediate future is concerned, I believe that the provision relating to the discovery and development of scientific talent in American youth through the granting of scholarships and fellowships to be most important. However, enlarged opportunities for the carrying out of scientific research must be provided very soon.

Since the very essence of scientific research is complete freedom to discover truths, any legislation which provides for the support of research must also provide for the complete freedom from interference. In order to achieve this, I am inclined to believe that the central authority in any program of support should be vested in a small group consisting largely, but not necessarily exclusively, of scientists. Scientists understand research and are best equipped to deal with problems involving scientific research. The National Academy of Sciences was established by act of Congress as the official advisory body to government in scientific matters, and I believe that full use of the Academy should be made in connection with the proposed legislation. I believe that the advice of the Academy should be sought, not only in connection with the controversial issues that have been raised by the various bills that have been proposed, but also in connection with scientific appointments relating to the central authority of any research foundation which might be established. Great care should be given to the composition of this central authority, for the success or failure of the entire research program might well depend upon this one single factor. It is true that facilities for research can be provided and personnel trained, but success will not result automatically. President Conant has stated, and rightfully so, that 1 first-class scientist is worth 10 second-rate scientists. I do not think that first-class scientists will be willing to participate in a program of research that is subject to political pressure or in which freedom of inquiry is not possible. Every effort must be made to preserve freedom of inquiry and to provide the necessary surroundings conducive to good research, so that first-class scientists will be attracted and will participate in the proposed program. Because scientists are so cognizant of the importance of such factors and have, during the past few years, demonstrated their ability to conduct research on an unprecedented scale, I think that the Congress should delegate considerable authority directly to scientists. And because the National Academy of Sciences was established by Congress for the specific purpose of providing

advice in scientific matters, I think that the Academy should be asked to function in connection with the proposed legislation.

I am inclined to favor that part of S. 1285 relating to the composition of the board because it is proposed to vest the powers of the National Research Foundation in a board rather than in a single director. However, I believe that six members of this board should be scientists appointed by the President after receiving recommendations from the National Academy of Sciences, with three members being distinguished lay citizens appointed by the President.

Such a board would bring much more experience and a more varied viewpoint to bear on the many problems that will confront the foundation than would obtain in case the top authority were vested in a single individual. In order to localize responsibility any member of the board should be permitted to file a separate report for the public record if he should desire to do so. Because of the great responsibility, the opportunity for public service and the limited term of service, I believe that the most distinguished individuals in the Nation could be induced to serve on such a board. I am, of course, aware of earlier testimony, especially of that of the Director of the Bureau of the Budget, which favors vesting the top authority in a single individual with the board relegated to an advisory capacity. It is held that such an organizational set-up is administratively more sound. I see some virtue in the arguments that have been advanced and wish that it might be possible to conduct an experiment and try out both plans. However, since that is impossible I am inclined to favor vesting the top authority in a board. In the final analysis it must be recognized that the type of the organization is secondary to the major objectives which are set forth in both S. 1285 and S. 1297.

I favor the division of the foundation as proposed in S. 1297 although it might be well to reduce the number of divisions by adding the division of publications and information to the division of scientific personnel and education. With respect to the committees within the divisions I favor the proposal carried in S. 1285 because I think that with the exception of the division of national defense, these committees should not have representatives of government. However, representatives of interested Government agencies should be invited to attend the divisional committee meetings. In other respects the provisions of S. 1297 appear to offer special advantages. I think, for example, that each division should be headed by an assistant director.

As a matter of principle I should favor eliminating from both S. 1285 and S. 1297 the provisions restricting the division of funds. This is a matter that could be left to the top authority of the foundation. I can visualize that at some time in the future it might be unwise and actually wasteful to spend at least 20 percent of the funds in a given division. If it is thought necessary to retain this restriction then I should be inclined to retain it for only a given length of time, say, 5 or 10 years.

I am in general agreement with the provisions of S. 1297 relating to the use and dissemination of research findings. I think that there should be prompt and free publication of research findings and that the results of federally financed research should not accrue to the exclusive benefit of any one individual or organization. I once thought that the patent problem had no place in the proposed legislation because it appeared separable and I thought it sufficiently important to warrant a separate study. However, earlier testimony, especially that of Secretary Wallace, indicates that such a study is in progress and that the provisions of S. 1297 would not interfere in any way. I think therefore that it is wise to proceed and do everything possible to insure the prompt and free publication of research findings.

Senator MAGNUSON. Dr. Steinbach, we will be glad to hear from you.

(Discussion off the record.)

TESTIMONY OF H. B. STEINBACH, ASSOCIATE PROFESSOR OF ZOOLOGY, WASHINGTON UNIVERSITY

Dr. STEINBACH. I am H. B. Steinbach, associate professor of zoology, Washington University, and managing editor, Biological Bulletin.

I am invited here as a working biologist, active in research and teaching. I have this prepared statement. There are 3½ pages which I would like to read, and I would like to submit the first part of my prepared statement for the record.

Senator MAGNUSON. Go right ahead.

(The material referred to follows:)

PORTION OF THE PREPARED STATEMENT OF DR. H. B. STEINBACH, ASSOCIATE PROFESSOR OF ZOOLOGY, WASHINGTON UNIVERSITY

Scientific research is a valuable national asset. It deserves support. This has been so ably expounded that we can assume the point has been made. In similar fashion it has been stated that the individual scientist should be encouraged to work according to the best dictates of his own scientific conscience. A companion principle is that basic research, insofar as it can be distinguished from applied research, is, from any long-range point of view, the most important phase of our national scientific life. Scientists have always known that theories developed without thought of immediate practical application are of fundamental value. The whole world is now aware of it. But the awareness does not always give comprehension of just what it means; that all competent investigators should be encouraged to collect any set of facts or develop and test any theory, provided only that the work is done with intelligence recognizable by fellow scientists.

In many instances, of course, immediate practical applications are recognizable at an early stage. Perhaps this is true more in physics and chemistry than in some of the other branches. In biology immediate practical values are seldom seen at the time the work is being done. Sorting out a lot of queer bread molds and developing theories of their interrelationships would probably have seemed silly to many, and yet such work was of great importance in controlling and guiding the development of penicillin. The medical use of penicillin is one of the outstanding achievements of modern times. Yet from a long-range point of view the most important work is the basic biological research that has been done or must be done. In a sense, penicillin is a brilliant light shining on civilization, but the important developments were and will be in the basic research powerhouse hidden from public view.

Not only medicine but also agriculture bases its practical advances on biological research. Each year our agriculturists are, for example, finding ways of increasing fruit yields by the use of sprays containing plant hormones. Such techniques have added greatly to our national health and income. But these techniques are only the application of basic knowledge about plant hormones which was developed by biologists who worked from a general interest in the problem of what makes plants grow. We may expect to benefit greatly from other future developments in applied agriculture; but we should bear in mind that such developments will be largely inspired by basic biological research.

Biology is the least understood and appreciated of all the basic sciences. Biologists as a group have never been primarily absent-minded bug hunters nor have they been people interested only in collecting animals and pickling them in alcohol. Biologists are people who are trying to draw predictable conclusions about the most complex systems known. Living cells, small bits of our own bodies, are so complex that they have defied complete analysis as yet. But investigations into them are opening up new fields of fundamental interest to other basic sciences. Many years ago, a botanist studied the shrinking and swelling of the tiny living units of plants. These observations, and conclusions drawn from them, allowed chemistry to develop some of its most basic theories in industrial use today.

It is unfortunate that biology is known best as it contributes to such great applied sciences as medicine and public health. Biology is more important than any of its practical fields. Biology has made its greatest contributions to social welfare by means of fundamental theories on which work toward practical ends is based, for biological science has literally been the wellspring of advances in medicine. Biology is a science in its own right and should be so recognized in any consideration of support of scientific research.

The need for support of general biology is in fact more crucial than for most other basic sciences because of the great diversity of its researches and researchers. A competent biologist today is apt to be required to know not only facts about both plants and animals, but, in addition, modern theories of chemistry, physics, and mathematics. For example, one who wishes to work on cell division, a

problem incidentally fundamental to cancer research, must be aware of the intricacies of the process as it occurs in many types of living things; and he also is quite apt to find himself using radioactive tracers, or doing some research on the chemical and physical properties of large molecules, or having a protracted session with the mathematics of fluid surfaces. This requires broad and extensive training and points to the desirability of one special phase of the bills under consideration. That is, the provision for training of young workers in the field. It should be possible for a promising student of biology to work uninterruptedly without worry about where his next meal is coming from. If it is difficult for him to get correct training in physics in his local school he needs to spend 6 months or a year at some other laboratory. He should, in short, be able to make use of the best facilities of his country. At more advanced stages he should be free to travel abroad should his field of interest call for it. It is an absolute necessity, for our national welfare, to support the training of students in the basic sciences. This support should be available at the earliest college levels. Otherwise we will lose in the future, as we have lost in the past, a large percentage of people capable of doing basic science research to industry and business where the financial rewards are greater with a much shorter training period. As matters now stand, many biologists feel impelled to tell prospective students, "Do not go into biology unless you see no other way of being happy. There is no assurance that your work will be supported and that you can earn a decent living when started." Private foundations, universities, and the National Research Council have all been helping to support promising young scientists. But the support is neither adequate for a given individual nor does it spread over a wide enough range. It is not possible to give a single comprehensive test and pick a great scientist. We must carry an overhead of extras from which the most able will emerge at any given level. Difficulties of selecting students may be illustrated by the story told that Gregor Mendel, the man whose experiments with sweet peas have revamped our agricultural economy, flunked his college exams cold.

It need not be pointed out again that basic science has done a remarkable job in the past. It is now in a position where any assistance at all cannot help but yield big dividends in comfort and safety for all. While some research projects are handsomely supported, the majority are not, and the majority of scientists are underpaid on a comparative scale. An eminent authority has recently noted how silly we are, as a nation, when we not only assume we can buy the biggest brains of the country for the smallest salaries, but then proceed to expect the big brains to wash their own dishes.

Testimony has shown that the medical sciences need much support, but the needs of basic biology are even greater. Because the biological roots from which spring fruitful developments in agriculture, medicine, and public health are hidden from the public eye, society has been chary in its support of biology. Business and industrial grants are generally made only for applied work in such fields as nutrition and pharmacology, and even the Rockefeller Foundation, an organization which has done an outstanding job in supporting fundamental research, has been far more liberal with medical science than with basic biology. Prior to 1944, for example, the foundation carried 60 projects averaging near $40,000 in medical science, and about the same number of projects averaging under $14,000 in basic biology. But basic science makes greater contributions to medicine than such sparing help would indicate. Taking the Nobel prizes as a criterion, we may note that more than a third of the prizemen in physiology and medicine do not hold the M. D. degree. They are holders of Ph. D. or Sc. D. degrees, which is to say that they were presumably trained in basic science, not applied medicine.

Senator MAGNUSON. I can stay late, if you gentlemen don't mind, but if you want to go, why it is all right.

Dr. STEINBACH. Basic science is in a position to benefit if Federal funds from any type of administrative set-up are forthcoming. It is, of course, earnestly hoped that any administration will recognize the need for freedom of the individual scientist and the need for participation of active research workers in the administration. Allocation of supporting funds for research should carry at least as much freedom as that found accompanying grants from private foundations. Under a typical set-up, a request for support of a general project is received by a foundation. This request is judged as much on the quality of the research worker as on the specific project. If approved, funds are

allotted to the nonprofit institution in which the scientist works, which then disburses the money at his instigation. Only the individual scientist determines the specific steps taken in the research work. In other words, scientific decisions are made by the people who apply for funds. To the administrations of the institution and the foundation the project usually remains only generally known until results are announced. This may seem a little like throwing money blindly into a river. In a sense it is, and it is up to any foundation or administration to pick out good rivers.

Thus the administration of funds for basic research is a subject of great interest and worthy of close scrutiny. Support must be made available in such a manner as to insure the preservations of the rights of the individual scientist to pursue his own lines of thought. Bills S. 1297 and S. 1285 differ somewhat in this respect. In the statement of basic objectives, S. 1297 gives its purposes as follows: "To provide for adequate public support for, and to otherwise encourage scientific research and development—." S. 1285 reaches somewhat past these goals and states, as a major objective, "To initiate and support basic scientific research and development—." S. 1285 thus appears to advocate a science foundation empowered to direct the specific type of work done. In other words, to initiate it. The desirability of this may be questioned.

The administrative plans for the two bills appear to follow directly from the philosophies expressed in the respective statements of purpose. S. 1285 creates, at the top of the foundation, an unpaid board, presumably of scientists. This board, acting under the directives of the bill might well feel itself charged with the true initiation of scientific research projects, allocating funds to those who will work on them. In contrast, S. 1297 provides for a Presidential appointment of a director, together with an advisory board with which he must consult on major policies. A single responsible public official, bound by the enabling act to "support and otherwise encourage" research would certainly hesitate before attempting to specify new projects which some other individual should carry out.

If it is agreed that basic research should be planned generally on the individual-scientist level, then it would seem to follow that the form of administration provided by S. 1297 is desirable.

It is interesting to note that, at first sight, S. 1285, with all control vested in a sizable board may appear to be more democratic so far as scientists are concerned. This would be true if the foundation was really intended to be a directive agency instead of one providing support and encouragement. However, the overwhelming preponderance of testimony already given, points to the necessity of having scientific decisions made by the men who do the work and plan the individual experiments. Others have mentioned the desirability of having as a director a single official with public responsibility and the difficulties in administering the over-all board set-up. Therefore, it seems apparent that the frame work provided by S. 1297 provides for a maximum of support and operational efficiency with a minimum of interference with the working scientists.

Science, as all other types of human activity, is not, of course, without its directive influences. Two of the most healthy of these influences that could be called directive are covered in both of the major bills under discussion. I refer to the provision for the dissemination

of knowledge by way of publications and for the promotion of national and international cooperation between scientists. Any increase in mutual understanding is bound to exercise a healthful controlling influence merely in telling every individual what is being done in his field and suggesting new angles of approach. This is the system at present. It works well and will work better with more support.

This discussion has been based mostly on the needs of basic science as carried out by the lone-wolf type of worker. It seems probable that group projects will grow in popularity and success as funds are available to facilitate such activity. Some suspect that the preoccupation of basic scientists with smaller individual projects is because they literally cannot afford, financially, to collaborate with any others more distant than the next room.

I note with pleasure that S. 1297, in the declaration of policy, specifically instructs the foundation to cooperate with scientific societies. The professional scientific societies are among our strongest scientific assets, and if basic research planning should be contemplated on other than the individual level, it should be restricted scientific society that functions first, since, by definition, they are the groups closest to the working scientist. These societies deserve the financial support and moral encouragement embodied in this provision.

Senator MAGNUSON. Doctor, would you advocate the publication, by Government appropriation, of a monthly or weekly, or whatever it is the Board may decide upon, journal?

Dr. STEINBACH. I think my inclination, having been mixed up in publication, would be to act through the existing agencies——

Senator MAGNUSON. There has been a suggestion made——

Dr. STEINBACH. Insofar as it is possible. I suspect a wise group in any of the particular divisional levels might request that sort of thing. The abstracting service, for example, needs considerable help in biology.

Senator MAGNUSON. Are there sufficient scientific publications throughout the country, if they were given free access to what the Research Foundation was doing, to cover the field rather than have them have their own journal?

Dr. STEINBACH. That would be a rather difficult question to answer. If the volume of basic research increased greatly, then many of our special journals would be past the breaking points. A survey carried out some years ago showed that most of the biological journals felt they published most of the papers they wanted to publish.

Senator MAGNUSON. How do most of the scientists feel about it?

Dr. STEINBACH. In my experience, the problem is not crucial except for the abstracting service, but it would be immediately there is an increase of stimulus to research.

Senator MAGNUSON. Within the authority of the foundation as suggested by these proposals surely they could work out some methods whereby the knowledge could be disseminated.

Dr. STEINBACH. The appropriate legislation I think in all the proposals could cover that adequately.

Senator MAGNUSON. They could well even use funds for that purpose. They could make a grant-in-aid to a scientific journal on some particular problem.

Dr. STEINBACH. I had rather judged the committee print of 1297 aid that rather specifically.

Senator MAGNUSON. Yes. You might be doing some work in the biological sciences whereby they could take—you probably have a biological journal, do you not? They might give them the money to publish what is being done, so all the biologists could know about it. I think we would rather work it out that way. I hope it is your opinion, too, that we would have possibly a Government monthly journal. I am afraid I might want to get some statements in there, and some of the rest of the Senators. You had better keep that free, too. [Laughter.]

The suggestion has just been made that the monthly journal be a catalog of all Federal papers. Would that be desirable?

Dr. STEINBACH. The full data on all experiments must be made available. Whether that is in the form of manuscripts or microfilm or anything of that description, is something the scientific societies have to settle themselves.

Senator MAGNUSON. We had a man, Dr. Davis, who said he represents a nonprofit institution, Science Service. Now the foundation could well subsidize and organize such as that, being nonprofit, to see that as great an amount of this material is available as possible.

Dr. STEINBACH. There have been in the past two or three attempts to have titles of papers in the major biological journals listed and sent to subscribers. I think they failed because of lack of funds. I found them very useful.

Senator MAGNUSON. Of course, Davis said, as I recall his testimony, this microfilm, if we could we will have all that right here in a very small building in Washington, for the use of anyone, and it could be transposed very cheaply. He also suggested that microfilm probably wouldn't cost as much as typing it out here, and possibly we could look forward to that.

Dr. Waksman, we will be glad to hear from you, sir.

TESTIMONY OF SELMAN A. WAKSMAN, MICROBIOLOGIST, NEW JERSEY AGRICULTURAL EXPERIMENT STATION; PROFESSOR OF MICROBIOLOGY, RUTGERS UNIVERSITY

Dr. WAKSMAN. Senator, I will try to summarize the statement I have prepared. I am from Rutgers University and the New Jersey Agricultural Experiment Station. I am a member of the National Academy of Sciences and of many other scientific societies. I presume I am the only one to speak for the lower form of life, the microbes. Most of the witnesses here speak for higher forms of life.

Senator MAGNUSON. You are against all microbes?

Dr. WAKSMAN. Not necessarily. It happens I deal with the beneficial microbes.

Senator MAGNUSON. There are two types. The ones I get are always bad ones.

Dr. WAKSMAN. For every harmful one, there are probably thousands of beneficial ones. I am going to try to present illustrations of those beneficial microbes.

Senator MAGNUSON. Doctor, I want to qualify you. You are the discoverer of streptomycin, which is comparable to penicillin and sulfa drugs?

Dr. WAKSMAN. Yes.

In developing a national program for scientific research with particular reference to the needs of biological science, the following three aspects must be given consideration: (1) Fundamental research; (2) collection and coordination of data in connection with scientific subjects already partly elucidated; (3) securing of biological information primarily from the point of view of its bearing upon national defense. These can be elucidated only very briefly. In presenting this testimony, the witness will draw largely on problems which he has encountered in his own work.

1. *Fundamental research.*—It may be considered as axiomatic that research as such cannot be planned too much and too far ahead. Either the scientific worker is selected for handling a particular problem and given complete freedom in carrying it through, or an investigator, no matter where he is located, who has developed a new idea or a new approach to a scientific problem is given all the assistance that he requires for developing the problem to its logical conclusion. It is not the contention of this witness that scientists should be set up in an ivory tower and be allowed to carry out their research work far removed from reality. However, it is his contention that a large part, if not the major one, of the fundamental research, whether it be within the field of physics and chemistry, or whether it fall within the biological sciences, is carried out by the individual investigator, the observer, the manipulator—in general, the research mind. He is the one to be given the needed opportunities by way of assistants, supplies, and other facilities so that he may go as far as he can with his investigations. If any of these lead to practical developments, advantage should be taken to bring them to their logical conclusion.

Society can thus only benefit from the results obtained, and the total financial expenditure involved will be returned in a manifold manner, aside from the increase in the fund of human knowledge. An excellent illustration can be obtained from the work on antibiotic substances. The practical results already derived from the use of penicillin and other antibiotics, such as tyrothricin and streptomycin, in terms of human lives saved, have no doubt already returned manyfold the original cost of developing these agents and probably millionfold the cost of the fundamental research that led to their discovery.

2. *Collection and coordination of information.*—It often becomes necessary to collect information that apparently does not lead to any immediate practical goal. A simple illustration from the work of the witness will suffice. For more than 30 years, he has been studying the microbiological population of the soil. Assisted by many students and collaborators, he has classified the bacteria, the molds, the actinomycetes. In order to satisfy the need for some practical results, he has studied the role of these organisms in the decomposition by microbes of organic residues in the soil, in the compost, and in the peat bog. Aside from these practical aspects, the major phase of the work appeared to be as purely theoretical and descriptive as one could imagine. Fortunately, he has lived long enough to see that the soil organisms have come to play as much of a part in the World War that has just been successfully finished as any other group of microorganisms. The fungi, bacteria, and actinomycetes that are now used for the production of antibiotic substances are largely soil microorganisms. It is these organisms, as well, that have largely been the cause of tropical deterioration of service materials, as will be elucidated

under the third heading. Who was to say, therefore, that information resulting from a knowledge of soil microbes will not prove valuable in the solution of important practical problems? Many times has this witness felt discouraged both by a lack of recognition of the importance of this work as well as by certain limitations to its progress. It is, therefore, felt that support given to scientific work of this nature will yield results that will help to unravel the still hidden secrets of nature, and will ultimately lead to the practical exploitation of the knowledge thus gained.

3. *Securing of biological information for national defense.*—In presenting this evidence, the witness takes the liberty of drawing upon information gained in his capacity as a member of the steering and administrative tropical deterioration committees of the NDRC. As soon as large concentrations of materials occurred in the tropical and subtropical areas of warfare under conditions of high humidity and high temperature, it became recognized that fungi or molds are the cause of a considerable amount of damage to service materials. This damage extended from the optical and electrical equipment to the clothing, tents, and other materials used by service personnel, and even to the human body. There was comparatively little information to draw upon, for the knowledge of the fungi, their physiology, and methods of control, except the limited amount made available by the work of the soil microbiologist and plant pathologist. A rapid survey had to be made of the nature of the fungi causing the damage, the role of the bacteria, insects, mites, and other lower forms of life, the nature of the damage thus brought about, the nature of the fungistatic and fungicidal agents required for the protection of different kinds of service materials, the methods for measuring the protection thus rendered, and a host of other problems. Under pressure of urgency and wartime conditions, it was only natural that the problems attacked should have been largely from the point of view of immediate necessity rather than that of a fundamental study. Here was a biological problem that should have been investigated in great detail, the results should have been coordinated and interpreted, and the information ready for use when required.

Who is to carry on a problem of this nature under peacetime conditions? The individual mycologist, the bacteriologist, or entomologist is interested in a single group of organisms under isolated conditions. The chemist may be interested in a single fungicide active under given conditions. It requires careful planning and coordination to bring all this information together into a system.

One must again reemphasize in this connection what has already been stated previously, that it is essential to recognize the interdependence of the natural sciences. Progress in medicine, for example, depends to a large extent on progress of bacteriology or microbiology, pathology, physiology, pharmacology, and of other biological sciences, as well as in the application of physics and chemistry to biology, thus giving rise to biophysics and biochemistry. To take the development of penicillin, for example. The contribution of the bacteriologist led to the work of the chemist and of the pharmacologist, and finally resulted in its medical application, thus broadening considerably the field of chemotherapy. In other words, the practical application of penicillin or its use for disease control had to depend upon the chemist, who isolated the penicillin; the chemist, in his turn, had to depend

upon the microbiologist who isolated the molds that produced penicillin, and who developed methods for testing of its antibacterial properties.

One cannot, therefore, be too emphatic in urging that it is in the interest of the Federal Government to support in every possible manner research in the biological sciences. These sciences have much to offer in increasing knowledge of natural processes, in improving and safeguarding human health, and in serving in many ways toward a well coordinated policy of national defense.

Finally, a word should be said about our position in the world of science today. The leadership in practically every field of science has passed to the scientists of the United States. It is to them that the scientific workers throughout the world will come for guidance and for help. We must be ready to justify their expectations and to give them the hospitality that American scientists have enjoyed for so long in the European centers. For this, science will need the help of the Government, so that its outstanding leaders can continue their work uninterrupted, and the fruits of their labors be made available to those that can benefit from them.

(Off the record.)

Senator MAGNUSON. Thank you, Doctor. Your point, Doctor, is that although this country, in your opinion, has a great need for advancement in all scientific research, applied and basic, the greatest need lies today in the basic science, and that possibly we are better set up to achieve the fruits of applied science than we are today in the developments of basic science.

Dr. WAKSMAN. In both. In other words, formerly many of our investigators used to go to European centers for their specialized training. Between the two wars many Europeans began to come here, but after this war there will be a flood of European workers coming here for advanced knowledge, and it is up to us to carry the torch of advanced science because we have the funds and personnel and it is our duty to do it. In other words, Germany will not be the center. The same is true of France and England, of course, will do its share, but it is our duty now to take over the torch, and we are in a position and it is our obligation to continue this work.

Senator MAGNUSON. We now have that position of leadership and we should continue it for our own welfare.

Dr. WAKSMAN. And for the welfare of the world.

Senator MAGNUSON. Now it has been suggested here that there be an exchange of students coming to America. Would you limit that exchange in any way or allow any scientist or any young man who wanted to take up science as a career to come in here for the purpose of study?

Dr. WAKSMAN. I would not limit it except where problems of national defense enter in. But otherwise, in most of the major sciences, and certainly most of the biological sciences, I should certainly say we should offer hospitality to all that can make use of it.

Senator MAGNUSON. Only limited in the use of national defense, where many felt the students of those countries should not come into this country.

Dr. WAKSMAN. Yes.

Senator MAGNUSON. I presume you are also in favor of one of the sections of the new proposal here that the Government itself take some active part in international exchange of scientific views?

Dr. WAKSMAN. Very much so. As a matter of fact, since 1924 I have had to travel six times to Europe to attend international conferences, to gather knowledge, to meet colleagues; I had to do it in practically all cases at my own expense and it was difficult. Of course, at one time or another the institution helped me a little. A grant was given to help at another time, but I went in most cases at my own expense and I can appreciate how in many cases it made it impossible for people to take advantage of that as they should have.

Senator MAGNUSON. Let me ask you the mechanics of that. Couldn't the governing group under this bill well carry out the recommendations of the particular topic, scientific group that they are dealing with, and come to them and say, "We would like to send six men, say, to England for this scientific congress. We have got so much money but we need so much more." Couldn't the Government well throw that extra amount in?

Dr. WAKSMAN. Yes, Senator; that is exactly the case.

Senator MAGNUSON. Now, Doctor, would you limit it, but think the other countries should open their doors to us, also, and allow our scientists to have a little training in their countries?

Dr. WAKSMAN. I should make that a prerequisite. If there is a country our scientists can benefit from, we should expect them to do so, and if any country refuses, we should refuse automatically our hospitality.

Senator MAGNUSON. It shouldn't be a one-way street?

Dr. WAKSMAN. Yes, sir.

Senator MAGNUSON. It is a matter we have to stress to the State Department. Maybe if their man had a Cabinet rank, Dr. Dunn, he could be more effective.

Dr. DUNN. Make a bigger push.

Senator MAGNUSON. I know you have your other difficulties and it is difficult to come to Washington. I don't want you to feel, because there are not a number of other Senators, we may hurry you along a little, that the matter you present will not be given deep consideration. I think we are making a record here in these hearings which could almost become, insofar as the Government officials are concerned in Congress, a scientific bible, and it will be a record that will be digested many, many times; it will be a record that will stand for posterity. It includes probably the whole realm of science—we have had them all here, and more to come, and I can tell you it is going to have a very salutary effect upon all Members of Congress, not only those here now, but those to come, and there will probably be a demand, I imagine, for half a million copies of this record before we are through. We already have them stacked this high.

Dr. Zirkle.

TESTIMONY OF RAYMOND ZIRKLE, PROFESSOR OF BOTANY, UNIVERSITY OF CHICAGO; DIRECTOR, INSTITUTE OF RADIOBIOLOGY AND BIOPHYSICS

Dr. ZIRKLE. My name is Raymond Zirkle. Since 1930 I have carried on research in the border field known as radiation biology. I am professor of botany at the University of Chicago and director of the Institute of Radiobiology and Biophysics which has recently been

established there. For the last 3 years I have been engaged in research on the metallurgical project of the Manhattan District.

My testimony will deal first with the need for Federal support of the biological sciences and secondly with the legislation which has been proposed to increase support for the sciences in general. I think I might well limit my remarks to the first category and simply include the rest in the record.

NEED FOR FEDERAL SUPPORT OF BIOLOGICAL SCIENCES

As pointed out by several preceding witnesses, research in the sciences is in general becoming more and more expensive, whereas the usual sources of money to support research, especially in the basic sciences, are not keeping pace. Under these circumstances, it would appear that, if the Nation is to maintain a position of scientific leadership, additional financial support must be made available. In view of the demonstrated importance of scientific research for the Nation's welfare and security, it would seem that the Federal Government might appropriately increase its support. Moreover, it appears probable that the Federal Government is the only source able to provide financial support on the large scale necessary adequately to advance the Nation's security and welfare. Discrepancy between the expense of research and the funds available was assuming serious proportions before the war. This tendency was magnified during the war by developments which greatly increased the need for basic and applied research, some of it very expensive to carry out. I should like to illustrate this by some remarks based on my own particular experience. It is obvious that the recent developments in the release of atomic power have very enormously increased the need and opportunities for research in the physical sciences, both basic and applied. What is not so widely realized is the fact that these developments have likewise enormously increased the need and the opportunities for biological research.

The need arises from the fact that the exploitation of atomic energy involves the emission of injurious radiations in amounts which before the war would have seemed fantastically large. Moreover, they are often emitted under circumstances which seriously modify their injurious effects with which no one had had any experience before the war. If we are indeed entering an atomic age, more and more of our population will live with these injurious agents as at least potential occupational hazards. At present, to be on the safe side, shielding against radiation must be designed with large safety factors and consequently becomes expensive both in cost of construction and in time of highly trained workers.

In order to minimize this expense and at the same time safeguard the health of the people, we need additional practical knowledge of the numerous ways in which radiations may produce injury and of what to do for a person who, despite precautions, becomes exposed. The best way to get this practical knowledge, if we may profit from the experience of other branches of science, is to obtain an understanding of the basic biological mechanisms of radiation injuries, and this can be obtained only by basic research involving the skills and knowledge not only of biologists but also of physicists and chemists.

The opportunities opened up by the new developments are chiefly of two sorts:

First, it seems probable that some of the new sources of radiations may serve to expand and improve the use of radiations in treatment of disease. Likewise, they may offer new opportunities for basic research in fields, such as genetics, which have used the prewar sources of radiations to great advantage.

Second, and to my mind enormously more important, the atomic power developments have increased the availability of the so-called tracer isotopes. These rare forms of the chemical elements, some of which have been available for roughly a decade, are the basis of research techniques of great effectiveness in unraveling the complicated physical and chemical processes which constitute the basic activities of all living beings. They are applicable to research in practically all branches of basic and applied biology, including medicine and agriculture. The war developments have not only increased the list of kinds of isotopes but they have enormously increased the potential availability of many which were very difficult to produce before the war. In the latter category are some notably those of the element carbon, whose value has already been proven in biological research and whose future value in results obtained would indeed be hard to overestimate. The cost of these isotopes in money is high, but since their use yields scientific results which can be obtained in no other way, they are cheap at the price. Here is a specific instance in which the Federal Government, by financial support on a scale too high for any other agency, could speed up the research output of many valuable scientific brains.

I have made the foregoing remarks, based on my own experience and observations, to illustrate the needs and opportunities for biological research which have arisen during the war—of course, a lot existed before the war—and to indicate how the Federal Government is probably unique in its ability to finance certain types of research. I am sure that other biologists can cite similar testimony from their experience.

REMARKS ON LEGISLATION PROPOSED TO INCREASE FEDERAL SUPPORT OF SCIENCE

It is with considerable relief that I note the Government taking active steps to greatly increase its support of research in both the basic and applied sciences. I can think of no better way of accomplishing this than by establishment of some sort of national research foundation, and I sincerely hope that some such device may be set up.

On the other hand, if such a foundation is set up and if its scope is as great as seems to be contemplated in the bills proposed, it will not be long before we shall have a substantial fraction of our scientific eggs in our basket. It is, therefore, of urgent importance that this device be as effective and workable as possible from the very beginning. With this in mind, I should like to offer some suggestions, based on the committee print of S. 1297 dated October 8, 1945.

(*a*) *Selection of the director.*—I note that several witnesses have dealt with this point. Persons experienced in Government administration feel that, to obtain workable administration of the foundation, it must be headed by a director who is appointed by the President,

by and with the advice and consent of the Senate, and who serves at the pleasure of the President. On the other hand, many scientists seem to feel that competent scientific leadership is of foremost importance and that this is more likely to be attained if the director be selected by and serve at the pleasure of a board, the members of which are appointed by the President for definite terms.

May I suggest that perhaps both of these points of view may be served by a modification of subsection 3 (a) to provide that the director be appointed by the President, by and with the advice and consent of the Senate and also of a committee of, let us say, 17 members to be chosen by the National Academy of Sciences from its own membership.

(*b*) *Use and dissemination of research findings.*—Subsection 7 (b) appears to give the director absolute power concerning what may or may not be published as a result of federally financed research. Some modification of this subsection, to give the investigator a voice in such decisions, would be helpful. I doubt that this is likely to be of any advantage to the Nation. The work of a scientific brain cannot be "drafted" by law. It must be "drafted" by consideration of public responsibility, as many have been during the current national emergency.

(*c*) *Subsection 5 (b)—National science reserve.*—Furthermore, a national science reserve, as described, might even be inimical to the national defense. If within the next year or two the National Science Foundation starts to grant scholarships and fellowships to persons showing special aptitude, we may reasonably anticipate that within 10 years a large and growing fraction of our best scientists will have been recipients of such grants and accordingly will be members of the national science reserve if the latter is established. As such, in case of declared national emergency, they could, by the provisions of subsection 5 (b), be drafted into Government service to do, without protest, work of any nature designated by the central authority, civilian or military, representing top leadership of scientific activities during the emergency. This would not be bad, if as in the current emergency, the top scientific leadership were good, but we cannot count on this to be the case every time. If the top leadership should happen to be poor, we should be in the predicament of having a large fraction of our research potential tied up in ineffective activities and, moreover, the top leadership would be in a very good position to conceal such a state of affairs from the President and the Congress. On the other hand, if no national science reserve were in existence and if accordingly the top leadership should have to draft each scientist, not by law but by convincing him of his public responsibility and of the worthwhile nature of the job proposed for him, the President and the Congress could immediately judge the quality of the top leadership by the collective response of the scientists. If the great majority should respond wholeheartedly, this would strongly indicate the top leadership to be sound and effective. On the other hand, if a substantial fraction of the able scientists should decline to serve, this would reveal to the President and the Congress an immediate need for critical examination of the top leadership.

(*d*) *General remarks.*—To me it appears that the most important consideration before us is that the welfare and security of the Nation demand an increase in our scientific resources on a scale which can

be financed by no agency less than the Federal Government. It is most encouraging that legislation to support scientific activities on a large scale has been introduced into Congress. I have suggested some changes in the form of the proposed legislation with a view to making it an instrument of maximum effectiveness in promoting the advancement of science and thus giving the public the best possible return for its money. The other witnesses have also made suggestions. I hope that all this discussion of the form of the legislation will not loom too large in comparison to the really important thing, which is the need for it.

Senator MAGNUSON. For the purpose of the record, what do isotopes do in lay language?

Dr. ZIRKLE. Perhaps it would be best to give one general example. One of the big difficulties in biological research is to find out what happens to a certain substance which is taken into the organism when there is already a lot of it there. For instance, we might consume sugar in the course of a meal. There is a lot of sugar already in the body. How do you know where the new sugar goes? That is important in order to understand chemical transformation of sugar in the body. If we can distinguish the new sugar molecules from the ones already in the body, we have a very powerful way then of seeing what happens to sugar, and these tracer isotopes are means of doing that.

In the case of sugar, one of the important elements making up the molecule is carbon. There is a race isotope of carbon called carbon 14, because it weighs 14 units, as distinguished from the common carbon which weighs only 12. That particular one happens to be radioactive, and the one which weighs only 12 is not. They act chemically the same, but this additional physical property of carbon 14 enables it to be detected in ways by which one cannot detect the other, and consequently we call it a tracer.

Senator MAGNUSON. What is the value of the tracing? I know what it is. When I was at sea, for instance, we had tracer bullets, and there was some value. We knew where the rest were going. Is that the same purpose you scientists have?

Dr. ZIRKLE. That is exactly it. It tells you where the newly introduced material goes, in a physical sense or chemical sense.

Senator MAGNUSON. And that might open up vast fields of knowledge regarding human organisms.

Dr. ZIRKLE. Not only human but all organisms.

Senator MAGNUSON. Which human beings are just part of, anyway

Dr. ZIRKLE. I go on now to Dr. Waksman's microbes.

Senator MAGNUSON. Let me ask you this. You had something to do apparently, from your testimony, with the radioactivity of the so-called atom. Could you tell us or enlarge a little upon your general statement that we have found out through the experimentation on the atom bomb and other experimentations on atomic energy, whether or not the radioactivity resulting can be dangerous or can be useful?

Dr. ZIRKLE. Any radioactivity can be either dangerous or useful, depending upon how it is applied. It is well known and has been for many years that X-rays can be used in treatment of certain disease. They are used under very carefully controlled conditions and directed to the site of the disease that is localized. On the other hand, X-rays in too large amounts or directed to the wrong place

in the body may produce very serious injuries. What I have just said about the X-rays will hold with any radioactive substances which have come out during the war.

Senator MAGNUSON. Now maybe you and Dr. Waksman can enlighten us on this, because there have been—I don't know whether they are founded or unfounded—wild stories regarding the radioactivity which follows the explosion of the atom bomb in the land, for instance, and in other places.

I think a lot of people are fearful that the radioactivity from the explosion of the bomb may be harmful for many, many years to come, that it won't just serve its war purpose, but it will keep on. Maybe you can explain a little on that.

Dr. WAKSMAN. Senator, I think you have here a very important problem; just the type of thing that fits in this problem. Here is something we have never thought of, have never investigated, and really it should be investigated. Here is where I think one of the functions of this Foundation, of this science organization that we are proposing, is not only to respond to questions by individual scientists for assistance, but they should have also a survey or planning unit which would investigate problems that are not being considered at the present time and approach proper agencies of proper organizations to take up those problems. Here is a problem of this nature which may be investigated only in a certain area, because certainly it cannot be done in New Jersey. It would have to be done in New Mexico, where those experiments have been carried out.

Senator MAGNUSON. As Dr. Zirkle points out, here is a problem probably too big for any one private group.

Dr. WAKSMAN. Exactly.

Senator MAGNUSON. Therefore, this foundation could take up a matter such as that if they deemed it advisable.

Dr. WAKSMAN. Or perhaps some wise scientist might call their attention to it and say, "Here is an important problem because it may affect not only the microbes of the soil, but the very composition of the soil itself to build crops generally."

Senator MAGNUSON. Dr. Zirkle, I don't want you to leave the second portion because now you are getting down to my business. We can pass it briefly, but I should like to ask you two or three questions on it. I note that you make a compromise solution of a matter that has given the committee considerable trouble, whether to have a director and a board or a director appointed. Your suggestion is that a bill section should be made to provide that the director be appointed by the President, by and with the advice of the Senate, of course, and also to have a committee of, let's say, 17 members to be chosen by the National Academy of Sciences from its own membership. Would you have them select one name or would you have them select, say, three names for the director?

Dr. ZIRKLE. To recommend to the President?

Senator MAGNUSON. Yes, following out your suggested compromise.

Dr. ZIRKLE. I think that would be largely up to the drafters of the act. The thing I was driving at there was to insure the approval of a recognized scientific body for the man who is selected, no matter where the selection is initiated, by the President or by the Senate or by the National Academy of Sciences.

Senator MAGNUSON. Of course, getting right down to brass tacks, there is a fear, which again may be founded or unfounded—experience may prove it groundless—that if you have one director appointed, he is apt to become, not particularly under this administration or maybe any future administration, but sometime in the future, a political appointee. Therefore, these scientists who are going to be responsible for the success or failure of this program might feel, "Well, if this is going to be a political show, our enthusiasm is a little dampened for it," whereas if you appoint a board or the foundation is run so that scientific knowledge and men of scientific experience determine its policies, they are apt to be more enthusiastic and cooperative, and therefore insure the success of the program.

Your suggestion is that in order to insure that this man is a scientist or is a man who has scientific ability, who could work with the scientists and they with him, he should be chosen from the Academy of Sciences or at least that there be restrictions around the type of man, whomever the President would appoint.

Dr. ZIRKLE. He would not necessarily have to be a member of the Academy and not necessarily a scientist—I am speaking of personal opinion—but he should be a man who knows about science.

Senator MAGNUSON. Or in whom the scientists have confidence. That is the main thing. I might say also that I don't think any of us concerned with this legislation would want a political appointment.

It is difficult to draw the right kind of language to insure against that, and when you get right down to it, either system is good if the men are good, but we are legislating here for the future and not for the immediate present.

Now, the other section in which the other suggestion occurs, Doctor, which you and I have not read at all. I wish you would just tell us what you mean by it.

Dr. ZIRKLE. Starting on page 3.

Senator MAGNUSON. A National Science Reserve. That has been giving us considerable difficulty here in the committee.

Dr. ZIRKLE. Incidentally, in this version the paragraph at the top of page 3 should come under that heading, subsection 5, and so forth. That paragraph was misplaced.

My fears may be groundless, Senator. Let's say, 10 years hence a very sizable fraction of our ablest scientists would be members of this National Science Reserve, as was suggested, and I note that in the committee print of 1297 provision is made that these members of the Reserve itself may be called into Government service in case of declared emergency.

I interpret the word "call" to mean essentially draft in the military sense of the term. Perhaps I am wrong there. If it does, it seems to me that there is a possibility of danger there because undoubtedly in case of an interpretation so that a top scientific authority will be established, either civil or military, and this top authority would have exclusive control over what these men do and say, and if the top authority should happen to be poor in its leadership, we would be in a very bad predicament, because we would have a large amount of our scientific potential doing rather ineffective work and, moreover, the top leadership would be in a very good position to prevent criticism of that.

If, on the other hand, we don't have a Reserve and all of the scientists are as they are now, comparatively free, they are in a position to criticize the top leadership, and the President and Congress can judge the quality of that leadership by the reaction of scientists when they are approved to go on emergency work.

Senator MAGNUSON. How are you going to know who should come in and who should stay out?

Dr. ZIRKLE. In the Reserve?

Senator MAGNUSON. Yes.

Dr. ZIRKLE. My inclination would be not——

Senator MAGNUSON. Well, yes, it has been suggested here. It has gone from one extreme to the other on this Science Reserve, particularly to those men who would be trained wholly by Government scholarships and funds, that this be brought in such as the Army and Navy military academies, requiring them to serve, and then at the end of a certain period of time, either leave or continue on. Second, that we set up a reserve such as the Army and Navy Reserve Corps, of officers, whereby a man would be free to do anything he wished, but in time of emergency it would be automatic that he would be called into the service of the Government; and even a fourth suggestion, that we set up, as you mention here, a scientific research, which would be a part even of the Army and Navy; and the last suggestion is that they be perfectly free after they were trained, to go anywhere they wished, to work for anyone they wished, but in peace and war we would keep a black book in which we would have the name of John Doe, that he was a biologist and was over here and that we could call on him in peace and wartime for a certain period of time. That would be quite difficult, too, because after all you would be using taxpayers' funds, and they may want to suggest that we have some strings upon these men because of that fact. But, as I recall, your suggestion would be to leave them entirely free to pursue after they graduated or were through——

Dr. BRONK (interposing). If there had been such a Reserve existing at the beginning of the present war, it would have been practically impossible for the Office of Scientific Research and Development to operate, provided membership in the Reserve gave the Army or the Navy authority to call them on active duty.

Senator MAGNUSON. Yes, sir; and I think possibly, unless we are going to have an America different than we anticipate, we will have no trouble in time of emergency in getting any scientist or group of scientists. We will get them anyway. They can contribute more to the general welfare, private and public, by just being scientists and working where they think they should work.

Dr. BRONK. Patriotism is your most potent directive.

Senator MAGNUSON. Dr. Griggs, we would be glad to hear from you. I hope the hour isn't too late for you gentlemen. However, if any of you find——

TESTIMONY OF DR. ROBERT F. GRIGGS, NATIONAL RESEARCH COUNCIL

Dr. GRIGGS. Senator, I think we are imposing on your time. I will take, I think, about 8 minutes with what I would like to read.

The membership of the Division of Biology and Agriculture of the National Research Council, of which I have the honor to be Chairman, includes the national professional societies in the plant and animal sciences, 26 in all. Several of these societies are to be represented by other speakers here with me on the panel, or in the testimony of subsequent days. The officers of about half of them, however, have asked me to present statements.

I shall not take your time by reading all of those statements but I would be glad if you would include them in the printed record.

Senator MAGNUSON. We will be glad to put them in the record.

Dr. GRIGGS. Before I begin, I should add that I speak only for the Division of Biology and Agriculture and not at all for the National Research Council as a whole. I ought to add that the National Research Council was set up by Executive order to advise the Government, and that it has no interest except the public interest.

There is substantial agreement among the professional people in the plant and animal sciences as to the subject of the bills before you. This agreement, I believe, extends up through the administration of the Federal establishment charged with operations in one or another of the plant and animal sciences and through the directors of the State agricultural experiment stations.

The judgment of the scientists in these fields is practically unanimous to the effect that while generous provision has been made by the Government for the application of the plant and animal sciences for the public welfare, there is altogether inadequate support for the basic researches upon which all applied science must rest.

There is also general recognition of the very great difficulty inherent in any attempt by the Government to provide for those fundamental researches in such a way that the public interest will be best served. There is, then, considerable uncertainty in the professions as to how far the bills now before you will actually accomplish the laudable intentions of their sponsors. The difficulties are largely inherent in the very nature of fundamental research but they are greatly accentuated by the system of appropriations on which government in the United States operates. It is very much to be hoped therefore that the propose National Research Foundation will be some thing other than just another Government agency and will be able to work with somewhat the freedom that has characterized university boards of trustees.

I think the Senator, in commenting on the difficulty of getting an appropriation from the Interior Department, made that point better than I could.

Wise support of fundamental research is exceedingly difficult to encompass. Experience shows that the most important researches were not at all appreciated when they were made. For a generation nobody saw the significance of Mendel's experiments. Yet Mendel's law was the foundation of the improved crop plants which permitted this Nation's record-breaking food production throughout the war. More than that, Mendel's law is the chief basis for all the hopes and expectations we cherish of further improvements in the future.

Now, 80 years after Mendel, his discoveries have just begun to be applied on a large scale, and that basically applies to basic research; there is a time element none but the Government can take care of. Certainly many other improvements like hybrid corn are on the way.

The present value of Mendel's law could not be measured in millions, yet it would have been impossible to secure even a few dollars to help his initial researches.

A generation ago, our fathers thought they understood nutrition pretty completely. One of the agricultural experiment stations tried to raise cattle on special diets which, however, contained everything that animals were supposed to need. The cattle didn't grow. The experiment station, being restricted to practical work, discontinued the study on the ground that it could have no economic value. But one man insisted on trying to find what was the trouble. He continued, using smaller animals that didn't eat so much. After years of work he discovered that the rats he was working with couldn't live on purified diets unless he added small quantities of things which he named vitamins. The denouement is coming just now. I will not allude to the vitamin craze which has gone to such lengths, nor will I enlarge upon the many problems of human nutrition which the United Nations are now studying in session at Quebec.

I will confine myself to one relatively small practical illustration. Turkey production used to be about the most hazardous of ventures in which a farmer could engage. Losses were tremendous. Now losses have been almost eliminated—through proper nutrition. As a consequence, the turkey crop of 1944 broke all records and that of 1945 is 20 percent larger still.

It takes about a generation for a really important research to bear fruit. The more important a research is the longer it takes, and the less it is appreciated at the beginning.

The experience of the institutions which have produced the most important basic researches is that the only way to foster this type of advance is to provide devoted and well-trained men with the necessary facilities and give them complete freedom to work on what they think is worth while.

Since no man can tell in advance which fields will be fruitful, the only way is to support all lines of endeavor that well-trained men have the enthusiasm to push into. Certainly no one would ever have suspected, for instance, that the study of a mold culture could lead into anything like penicillin.

It is impossible to get much support for basic research in the established Government set-up. I have talked with a number of bureau chiefs and directors of experiment stations recently. All agree that they cannot get funds for basic researches which they believe in the end would bring far greater returns to the taxpayer than the applications for which their appropriations are earmarked.

Every one of these men, devoted public servants all, is hoping that this proposed Research Foundation will remove basic research from the necessity of immediate economic justification so that it can go forward in the volume and in the variety which the public interest requires.

Senator MAGNUSON. I might interrupt there and say surely in the appropriations for such a foundation we cannot put the Government fiscal-year limitation upon them.

Dr. GRIGGS. That has been one of the things which has most encouraged scientists to believe this foundation would actually accomplish what you desire.

Senator MAGNUSON. Because even in agriculture they might set a man on basic research and come July 1, if the Congress don't appropriate funds for that particular thing, but it doesn't go on. Is this correct, you can't put a time limit on basic research? It may come in a month; it could come in 10 years.

Dr. GRIGGS. And it may not come at all.

Senator MAGNUSON. It may not come at all. Go ahead.

Further, it must be remembered that only one in a thousand basic researches ever pan out in any big way. But that one more than pays for all the rest. The income taxes collected by the Federal Government from profits to farmers from hybrid corn can be readily shown to exceed every year the total funds spent for biological research in this country.

But it should not be supposed that the other researches which never pan out by way of direct economic returns are wasted. They render two very important public services: (1) They build the foundation on which all further advance in both pure and applied research must rest; (2) they help train and maintain that body of scientific workers which is essential for the national welfare.

As a matter of fact, strange as it may seem, it is easy to demonstrate that these basic researches return much more on the investment than the applied researches.

I have said nothing about the texts of the bills before you. That was deliberate. There have been so many amendments offered that I do not feel at all sure just what is the present thinking of the Senators and I should have to be in very much closer touch with proceedings here than I have been able to keep, before I should wish to comment much on details.

I may say, however, that I like features of both of the principal bills before you and that a judicious combination of them would be better than either alone—at least as it was originally proposed. As offered in July, the Magnuson bill was more specific in stating the powers and duties of the foundation and thus permitted a clearer view of what was contemplated. I think this is advantageous. I believe that the Nation requires provision for basic research over a broader field than was mentioned in the first drafts.

That has been taken care of and excused pretty much this morning and I needn't go into that.

There has been a good deal of debate as to the governing body of the proposed foundation. Either of the proposed methods might work well. I would, however, point out that those institutions which in the past have been most successful in promoting fundamental research—the universities—are put in charge of a group of public-spirited trustees who are responsible to this public for the general conduct of the institution, but delegate detailed operation to an administration and faculty answerable to them. I should like to point out that there already exists in the Federal establishments, an institution controlled by a board of regents, like a university. It has operated with distinction for more than 100 years. It was, indeed, created for purposes essentially similar to those of your bills and its directive might well serve as an epitome of your purposes. It was created for "the increase and diffusion of knowledge." I refer, of course, to the Smithsonian Institution.

Senator MAGNUSON. Thank you, Doctor. I want to say I think you make an awfully good point in your statement when it comes to appropriations for this foundation. You agree with me, do you not, that this as the premium for this insurance would probably be as wise, this scientific insurance, as any money the Government could expend?

Dr. GRIGGS. I think after a few years that would show to be the case. I think you could never justify it in advance.

Senator MAGNUSON. Never in advance and probably we will have a great deal of difficulty in justifying sufficient amounts the first 3, 4, 5, 6, or 7 years of its existence. Once they can be responsible in developing hybrid corn or something of that nature, we will be all right from there on in.

Dr. GRIGGS. I think the University of Wisconsin was run for a generation by the Babcock Cream Separator.

Senator MAGNUSON. Although I might say that I have had very little difficulty and I was one of the authors of the Cancer Institute bill, and although we don't usually see anything concrete, I had very little difficulty getting the annual appropriation for that institute, and it may be years before something comes out of it.

Now, Dr. White, I am sorry to have you way at the tail end, but we would be glad to hear from you.

TESTIMONY OF DR. PHILIP R. WHITE, ASSOCIATE, ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

Dr. WHITE. I am an associate of Rockefeller Institute here as delegate for the American Association of Advancement of Science to the National Council of Scientific, Professional, Artistic, and White-Collar Organizations, but I am speaking as an individual and not officially for either of these organizations.

Senator MAGNUSON. Doctor, let me ask you for the record, because we are not clear here, what is the difference between the National Academy of Sciences and the National Council?

Dr. WHITE. This has nothing to do with the National Academy of Sciences.

Senator MAGNUSON. Two different things?

Dr. WHITE. This is an organization of organizations. It is a group of about 70 societies extending all the way from the American Medical Association to the Union of Office Workers, CIO.

Senator MAGNUSON. These are like Government agencies? One is the AAA's and the other, AAW's?

Dr. WHITE. That would be all right. I am speaking as an individual; what I have to say is quite brief and a little different from most of what has been said. I think I want to throw at least one shell into the story. I would like to start off by saying I strongly support Professor Dunn's contention that this Foundation should have cabinet rank and also the suggestion of scientific attachés to other countries. I believe the British Commonwealths do have such attachés. I believe that is the only group in which they have such an official standing. Needham, for example, was sent to the San Francisco Conference as an official science delegate from the British Government, and he has such an official standing at present, in the British Commonwealth.

What I have to say is the result of discussion with a great many people. There are four points which I think are consistently and almost universally agreed upon:

1. Legislation authorizing governmental support of scientific research and development is clearly desirable and should be enacted at the earliest possible date.

2. Whatever foundation is set up to this end should be under the direct control of men fitted by training and experience to evaluate the problems approached, from a scientific point of view, and to administer them impartially and efficiently. This end can be attained only if the majority of the Board is made up of practicing scientists and if there is no voting participation by ex officio members from other governmental departments. In this respect we are universally against the Kilgore bill. We recommend that authority be vested rather in a nine-man board as suggested in the Magnuson bill, appointed by the President with the approval of the Senate. Seven members of the Board should be appointed upon recommendations of the National Academy of Sciences and on the basis of demonstrated competence in the planning, supervision and conduct of scientific research or its administration. Two members of the Board should be lay members chosen by the President and representing public participation in the board's activities. The Board should choose its own director (or a directorial committee of three) who should then be responsible to the President.

Senator MAGNUSON. And Government representation should be on the next lower level of the panels and divisions we attempt to set up, projects level.

Dr. WHITE. If it is to be set up in the present form, then Government participation should be at those lower levels.

3. All research results should be given the greatest possible freedom of publication and the widest possible dissemination both national and international.

4. As a corollary to point No. 3, all patent rights on discoveries or inventions made or developed with public (governmental) funds should adhere wholly to the public. Whatever provisions are necessary to this end should be written into the legislation in its final form. If such patent clauses tend to result in hesitation on the part of large industrial concerns to participate in the work of the Foundation this will be all to the good since such concerns do not need Government support, and small businesses and the general public stand only to gain from a rigorous patent policy.

Certain other points are less universally agreed upon but are worthy of note.

It seems clear to me that we have here three main objectives which are not mutually inclusive and which should be kept quite separate. These objectives are:

1. National safety (national defense).
2. National welfare.

Senator MAGNUSON. Of course, the plan or organization which is used in Government is usually three general types, one the main type, a director with so-called advisory board, the other, a board which appoints an administrator or director, and my original thought was, that this being of the nature it is, this legislation, and looking at most of the other institutions dealing with scientific problems, they

all seem to take the pattern of having the board, such as universities, as Dr. Griggs pointed out, the Smithsonian, my own Cancer Institute, and even the latest, the message from the President himself in setting up the atomic committee in the same manner. I say I don't know which is best. I suppose it all depends on who does it in the long run.

Dr. WHITE. So long as it represents scientists and functions with the support and advice of scientists, I don't think the details are particularly our concern. We may not be able to decide how best it is done, but we want to make sure it is done through the citizens. As a third point, I think the international aspect should be stressed.

Senator MAGNUSON. In any event, you feel that whatever Government participation occurs, in private research institutions, that the Government's rights in any patents that come out of that should be protected?

Dr. WHITE. Yes.

National defense is a matter of prime importance and deserves every possible consideration. It requires, however, a very considerable degree of rigid control and secrecy and should be under strict governmental control. But there is another aspect of the problem which seems to have been missed by most, though not all, of those who have discussed the matter. National defense is not a problem of science. It is a problem of technological applications of science. It has been pointed out repeatedly in these hearings that our extraordinary progress in national defense in the past 5 years has not involved a single new scientific discovery and has, in fact, been possible at a time when scientific research was actually practically at a standstill. Let us recognize that fact. When we talk of controlling science in respect to the atomic bomb, our national defense—or small business—we are indulging in a dangerous non sequitur. That is why scientists have been so universally against the May-Johnson bill, and are so suspicious of these Kilgore-Magnuson-Fulbright bills, because these bills so often talk "science" when they mean "technology." I am quite certain that no scientist would seriously oppose the idea or rigid control over and secrecy for the mechanics, the processes, the tabulated records, blueprints, etc., on the atomic bomb. But they know that if those same principles of control and secrecy had been applied to the scientific studies in atomic fission over the past two decades we would have had no atomic bomb. And those principles can be equally dangerous for the future.

This being the case I feel strongly, and I was gratified to hear that Secretary Forrestal expressed the same belief, that the national defense clauses and the science clauses should be completely divorced and that two entirely separate foundations should be set up. Both the Kilgore and the Magnuson bill now call for a division for national defense within the science foundation. This division is to command rigid control and possibly secrecy while the natural sciences, medicine, and the social sciences are to be permitted a considerable degree of freedom. I do not believe that that is administratively possible.

Senator MAGNUSON. The Secretary of War thought they need not necessarily be in conflict, that the division of the War Department dealing with research could come to the foundation with certain problems. They thought the foundation might well take it up. But of course, I can also see your point, that they could come to the

foundation and say, "Look here, what you are doing over here has great bearing on military affairs. You better keep all that secret."

Dr. WHITE. That is what I am afraid of.

Senator MAGNUSON. But you think maybe your fears are not as great as you anticipate, because after all, the division of national defense need not be controlled; they would have to convince—this is an interpretation—the foundation that it was in the interest of national interest, that secrecy.

Dr. WHITE. You might be able to work it out.

Senator MAGNUSON. I assume the foundation would not allow that unless they were convinced it was in the interest of national interest.

Dr. WHITE. Let me give a few examples. I am a biologist studying problems of nutrition. My work foresees applications in public health, in medical practice, and possibly in military surgery. I can quite well foresee that the division of national defense may some day say "This work has a direct bearing on military problems. Therefore it comes under our jurisdiction and must be kept secret." Or they might go to my colleagues who are working on blood-plasma chemistry and say, "These are problems of importance to the welfare of our armies. They must therefore not be published," and thus not only strangle those scientists but cut off at its fountainhead one of the major sources of the sort of information which I must have to build toward even totally nonmilitary ends. That could be disastrous to the national welfare. I think that the only way to avoid that risk is to keep the two under separate organizations. That will probably involve some duplication of effort, but I would rather have that than run the risk of national defense swallowing science.

Senator MAGNUSON. They have adopted a wise policy in this extent, even down to a mechanic in the navy yard—if he is working on something that is of vital defense nature, in working on that, if he discovers a portion of that that has a commercial application, they will allow him to go out and disseminate that knowledge. But the point you make is, of course, one that bothers us all, and it would be possible. If you had those people working off in one room and the foundation in another room, they may be pulling each other apart. I think maybe they could get together on what is of national security and national interest by sitting around the same table. That was our thought.

Isn't it better that it should be connected with the scientists themselves, instead of being isolated, and then they can come to a common agreement as to what is and what is not to be kept secret? It should be done with the consent of all concerned.

Dr. BRONK. I would like to make two observations pertinent to this point. In the first place, even though you had national defense covered in a different agency, there would still be, if the director in the board were going to be that vulnerable, the chance that they could come to the foundation and say, "This work has to be kept under cover," and my experience with the Army for the last 4 years has indicated a very liberal attitude towards the dissemination of information that is properly the problem of all science.

Senator MAGNUSON. Go ahead, Doctor.

Dr. WHITE. I should like to make one more personal plea. The Magnuson bill now calls for support of the "medical, natural, and social sciences." That is wrong. Medicine is a technological branch

of natural science, taking its fundamentals from biology, physics, and chemistry. Public health and medicine are no more sciences in themselves than are national defense and naval ballistics. To set them up as distinct sciences is to lose the proper perspective and is likely to lead to a weakening of our basic sciences upon which all this which we are discussing must rest. Let us not forget our foundations. I hope we will soon have a national research foundation, not a national technological fabrication without proper foundations. I believe we should have a division of basic sciences, including medicine, but I don't like this idea of two parallels. I think they had better both be in the same division, but with medicine as a branch of basic science.

Senator MAGNUSON. That would surely satisfy the gentlemen here.

Dr. DUNN. Not me.

Senator MAGNUSON. May we suggest one other thought here, and this is from personal experience. We have had in the Army and Navy, peacetime and war, a Research Division. The Navy, I think, has gone into it more thoroughly than the Army. And they would come before my committee for many years, when I was in the House, and ask for an appropriation. In 1940 they asked for the small sum of $20,000,000, and in that moment we were appropriating 8 or 9 billion dollars for the future development of the Navy, and the committee cut out the 20 million.

I think the Army and Navy are more apt, if they become a part of this thing, to get more consideration before Congress than when they come up by themselves for this type of work, because as you point out, some people can't see the value of it. They say, "If you are going to have this from July 1, what are you going to accomplish?" and then you come back the next year and say, "We can't tell you anything; we just spent the money; we have hopes." They are apt to get cut.

Dr. WHITE. So you feel the military research might better ride in on the basic science?

Senator MAGNUSON. Not necessarily, but if this supplements it, I think it will make their plea a great deal stronger to do the thing they would like to do. That is just my thought.

Dr. WHITE. Such a separation of defense and basic research would serve one other purpose as well. Technological processes, such as are of great importance to national defense and to business, big as well as small, are highly patentable. A strong patent clause is of the greatest importance in any bill covering these problems such as the Byrd and Fulbright bills. But scientific discoveries, principles, laws, theorems, and so forth, are seldom if ever patentable stuff. A patent clause is pretty much of a fifth wheel in a real science bill, and a clear separation would go a long way to eliminating much of the opposition that now exists against this legislation.

Senator MAGNUSON. Thank you, Doctor. I am very sorry we had to limit you eminent gentlemen this morning, but that is the nature of things, and it couldn't be helped. If anyone has anything to add for the record, we would be glad to have it, any discussion.

Dr. BRONK. Mr. Senator, I would like to ask permission to submit a statement for the record prepared by Professor Taylor, dean of the School of Biological Sciences at Stanford University. He is competent to represent the point of view of Pacific coast biologists who I think you would agree should be heard on the record.

Senator MAGNUSON. Certainly.
(The material referred to follows:)

OCTOBER 18, 1945.

CHAIRMAN OF THE HEARINGS COMMITTEE
ON SUPPORT OF SCIENCE RESEARCH,
United States Congress, Washington, D. C.

DEAR SIR: Prof. J. S. Nicholas, president of the American Biological Society, and Prof. Robert Chambers, president of the Union of Biological Societies, have suggested that I write you to indicate the concern of Pacific coast biologists in the current hearings of your committee.

It is hardly necessary to say that biologists out here, as elsewhere no doubt, are deeply interested in the outcome of pending measures for Federal support of science research now being discussed before you. Also it would seem that scientists generally would welcome that support in view of the tremendous strides that American science is certain to continue to make if commensurate funds are made available and are wisely allocated with no undue restrictions.

Evidently also, the public mind is now keenly awakened to the possibilities and the necessity for continuous, unhampered scientific research, due mainly to its startling contributions toward winning the war. Science has now popularly come of age and may hereafter be assured of general public support.

It would appear, however, that the adequacy of that support will require some clarification of scientific procedure and rate of progress, which your committee hearings will doubtless greatly facilitate. Along with present world-wide recognition of science, there goes a kind of popular awe and wizardry about science and scientists that is fallacious and deceptive. The atomic bomb, penicillin, sulfa drugs, DDT, and the other brilliant achievements of science during the recent war years made the headlines of daily news everywhere. These culminations of scientific research were readily appreciated by everyone. Yet how few well appreciated that back of each one of those great achievements were the years and years of critical studies of numerous, unheralded scientific workers whose detailed results were made and published without reference to any likely immediate application. Nor could anyone at the time have predicted that those results would be indispensable steps which culminated in such revolutionary engineering and medical advancements.

All of this strikingly illustrates the essential procedure in scientific progress and makes it certain that if our American science is to maintain its leadership in the future as it has in the past, then adequate financial support, much greater than ever before, must be provided those investigators first of all in the so-called pure sciences, recognizing that upon them depends continued progress in the applied sciences, such as agriculture, engineering, and medicine.

It is further evident to you and your committee, and should surely be made more evident to the public, that our rate of progress in research depends no less upon the publication and ready availability of research results to any and all doing research. This, of course, means the undelayed publication and distribution of American scientific findings. Among our current journals, one of the most useful and essential for American biologists is our Biological Abstracts. This journal, as I can personally testify, has been struggling unduly and needlessly during the past many years because of inadequate funds. And now that its counterpart in European countries has entirely disappeared, there is all the more reason for the adequate support and development of this abstract journal which may properly become the leading abstract journal of the biological sciences throughout the world.

Sincerely yours,

C. V. TAYLOR,
Dean, School of Biological Sciences.

THE ECOLOGICAL SOCIETY OF AMERICA,
Woods Hole, Mass., October 17, 1945.

Hon. WARREN G. MAGNUSON,
United States Senate, Committee on Commerce,
Washington, D. C.

DEAR SENATOR MAGNUSON: Allow me to acknowledge your letter of October 10. I enclose a statement for the record on S. 1285 and S. 1297 on behalf of the Ecological Society of America which has been prepared in accordance with your suggestion.

Sincerely yours,

ALFRED C. REDFIELD,
President, Ecological Society of America.

STATEMENT ON S. 1285 AND S. 1297 ON BEHALF OF THE ECOLOGICAL SOCIETY OF AMERICA

The Ecological Society of America is a national organization of scientists whose object is the promotion of the interests of ecology. As such it is concerned with the development of the basic sciences which underlie the conservation and development of the biological resources of the Nation. Its membership consists of 656 individuals and 19 subscribing institutions. Its members are engaged professionally in university and college teaching and in research in botany and zoology, including such specialties as forestry, soil science, game management, land use, fishery biology, oceanography, and limnology. The scientific personnel of the Foresty and Soil Conservation Services, the Fish and Wildlife Service, and other similar Government agencies includes 47 of its members.

On behalf of the Ecological Society of America we submit that the Kilgore bill, S. 1297, and the Magnuson bill, S. 1285, are both admirable in their recognition of the need of encouraging advancement of science. However, both are defective in failing to implement explicitly the development of the biological and earth sciences on which the full conservation and utilization of natural resources depend.

The Kilgore bill provides in section 101 for the development of natural resources as well as for support of activities in the fields of national defense, medicine, and the basic sciences. Section 202, however, establishes only a defense committee and a medical committee to implement these objectives. It makes no explicit provision for the responsible development of the basic sciences in general or for those particular groups of scientific specialties which underlie the development of the biological resources of the land. The provision in section 202 (c) for additional advisory committees is inadequate to safeguard the interest of these fields. To properly implement the objectives of the bill, there should be provided in addition—

(1) A Research Committee for the Basic Sciences to provide for the development of fundamental knowledge in physics, chemistry, biology, geology, oceanography, and meteorology; and

(2) A Research Committee for the Development of Natural Resources.

The Magnuson bill makes no provision for the conservation and development of the natural resources of the land, on which the future strength of the Nation depends. It does not provide adequately for the development of the sciences required for such purpose.

The bill provides in section 2 for the support of basic scientific research in the biological sciences, but the programs of research in these sciences are to be carried out under a Division of Medical Research, according to section 5 (a). This provision is inadequate to insure the full development of the fundamental biological sciences and their application to fields other than medicine.

If the Magnuson bill becomes the basis of final legislation, its provisions should include—

(1) Power and duty to support scientific research on the conservation, development, and use of the natural resources of the Nation;

(2) A Division of Natural Resources to implement this power; and

(3) A Division of Basic Sciences enlarged to include biology and the earth sciences coordinate with mathematical and physical sciences.

EXECUTIVE COMMITTEE, ECOLOGICAL SOCIETY OF AMERICA,
ALFRED C. REDFIELD, *President.*

Dr. DUNN. Here is my article from the magazine Science.
(The material referred to follows:)

ORGANIZATION AND SUPPORT OF SCIENCE IN THE UNITED STATES

(By Dr. L. C. Dunn, professor of zoology, Columbia University)

The war and the sudden need to improve means for supporting and directing war research have brought into high relief an important fact which has been dimly recognized for many years: There has been in the United States no orderly means for the continuous support of fundamental scientific research, and no policy or method for the deliberate utilization of science by our society. Science has been a hardy plant which grew where and how it could, thriving in the comfortable greenhouse of a research institute, or turning ample fertilizer into real fruit in an industrial laboratory, or in the more usual case struggling for sustenance in the thin soil of colleges and universities, occasionally enriched by temporary growth stimulants from a foundation or private donor. Except in the case of

certain industrial developments and in a few Government departments, the support of science in the United States has not been the result of decision but of chance, operating in a milieu which contained good scientists and a good deal of fluid wealth.

The most blunt and truthful statement we can make about the reason for the lack of continuity and of public policy regarding science is that, as Americans, we did not want either continuous support or direction or planned application of science. The detailed causes of this attitude trace in part to reasoned premises and in part to prejudice; and from these there has resulted a confusion of thought which the war has now revealed.

The contradictions come out most clearly in the views of scientists concerning the support of science after the war. Most of them hope for release from the capricious and precarious methods by which fundamental research was chiefly supported before the war, namely, by periodic begging from donors, such as foundations who chose the researches to be supported. Scientists generally hope for a more orderly and stable means of support than this, yet most of them would not turn to the Federal Government as the source of more continuous support. They profess to fear infringements on their freedom more when support comes from their Government than when it comes from private sources.

There is no sense in dodging or belittling the dilemma in which this places science. On the one hand, the war agencies which have guided and financed a large segment of scientific research propose to withdraw from this function. If they do, the public investment in scientific research will drop to a third or a quarter of its present level. At the same time, the principal sums in the hands of the great foundations are declining, and science must adjust itself to diminishing support from this and other private sources, and possibly to the extinction of this sort of financial aid within another generation. There will eventually remain as sources of support chiefly industry and business, through their research laboratories and foundations, and the Government, through its own scientific agencies or through new channels yet to be created.

Most scientists who do not like "domination of science by Government" like "domination of science by industry" even less; and many have already objected to the influence which the foundations wield because of their control of the fluid funds with which to supplement the fixed investments of universities and research institutes in men and permanent plant. It has often seemed that this small tail of free funds has wagged the larger dog of solid investment.

Moreover, scientific research depends upon trained men and women as much as upon material facilities, and we have as yet made no provision for assuring a steady flow of young scientists into research. For advanced training we have relied upon the existing scholarships and fellowships of the universities, which are so meager that most young scientists can devote only a portion of their time to learning, the rest being needed for earning a living; and upon the advanced fellowships supplied by foundations, private philanthropy, and industry. The same considerations of approaching exhaustion of private funds apply to the training of persons as to the provision of research funds.

The facts that must be faced are, then, that the present means of support of science are running out and, whether we like it or not, changes in the sources and form of support will occur; and that a chief desideratum for scientists will be to keep science under the new conditions as free as possible to develop according to its own inner needs and according to its function in society.

In the following pages I propose to discuss, first, what the function of science is that entitles it to support; second, what determines the attitudes of scientists toward forms of support; third, what general public policy toward science would represent the best interests of science and scientists; and fourth, how this policy could be implemented in practical ways.

At the bottom of every consideration of science in its public aspects must lie the question: What is science for? When this question is squarely and thoughtfully faced, scientists will agree that science exists for man and not for itself alone. As a means of understanding the material world, it leads toward the improvement and control of the environment in which human society must always operate. Eventually, its results and the methods of thought which it develops accrue to the public good, not merely by increasing the physical well-being of the people through technological applications but also by extending the domain of reason and by increasing our understanding and appreciation of nature. In discussing the material means which have to be provided for scientific research, it is often forgotten that the great and lasting changes wrought by science are in men's minds and that, in the end, science is to be supported for the same reason that

education is to be supported. The products of science are primarily increase and diffusion of knowledge and increase in the number of trained minds; and secondarily, increase of technical facilities and production of goods. Like other knowledge, scientific understanding is one of the "rights" to which all citizens should have equal access. Its support, like that of education generally, is thus to be shared, as most essential activities are in our society, by the State and by "public spirit" as it acts through foundations, private citizens, and industry. At the material level, science in the modern world has become a public necessity without which technical advances and social developments determined by them cannot occur in an orderly way. It has become so "affected with the public interest" that its support must be a matter of public concern. The scientist has thus become in some sense and in spite of himself a public servant.

Those many scientists who are serving their country in the war as scientists are less likely now than formerly to forget their public function; but in the past a failure to recognize this led scientists as a class to have too little confidence in seeking support for scientific work. They were not sure that science was worthy of public support, because oftentimes science was not what the world needed but only what they enjoyed doing. They did not generally think about a public policy for science, because they were not clear about the public function of science. Can we really expect (they would say) the public to support this kind of work? Or, as a small boy said to a scientist after a visit to his research laboratory, 'Uncle, do they really pay you for doing this?"

When questions about the organization and support of science were raised, however, other reasons were generally given for either opposing the formulation of policy or avoiding the question altogether. These reasons took different forms, but in general had their roots in our tradition of individualism. Since scientists have usually been strong individualists, the traditional public objections to schemes for the support and direction of science have been strengthened and rationalized by the scientists themselves. They said: "Organization kills initiative," "Planning interferes with free enterprise," or "Continuously assured support removes the need for periodic justification of each research on its own merits." "Support implies direction, and he who pays the fiddler will call the tune; and only scientists can know what tunes can or should be played."

These are valid and weighty objections, and they must be squarely met by any general proposal for the maintenance or direction of science. It is nevertheless true that these are not the primary or real reasons for opposing the formulation of a public policy or even specifically for opposing the support of science from public funds, since the same scientists who use them against government support approve the use of organization, planning, continuous support, and central direction when these are employed, as a matter of policy, in the great industrial laboratories. In fact, many scientists point with pride to the splendid results which industrial laboratories have achieved under the very conditions which they allege would impede and stifle scientific research done at the expense of government. Moreover, public support and direction appear to have been quite acceptable in the great program of agricultural research which has been in operation since 1887 through the United States Department of Agriculture and the State agricultural experiment stations. These facts are not cited to minimize the difficulties involved in planned continuous support and direction of research. They do show clearly, however, that the objections are generally not to support and direction as such but to these only when the authority which wields them is the Federal Government. As the attitude toward agricultural research shows, the objection does not apply with similar force to the State governments. Many scientists have expressed the fear that central and especially Federal support of scientific research would put an end to scientific freedom and lead to regimentation. In most cases it is the threat to scientific individualism or free enterprise in science that is the real cause of fear. Since such changes in modern society as the decline of individualism are not due to deliberate acts of governments but result from the social and economic and technical developments of our age, they call, not for fear, but for a greater effort to understand them.

I believe that most scientists have come to realize the nature of such objections to discussing general policies for the public support of science. The central position that "pure science," especially physics, came to occupy in war research revealed facts about science in the modern world which simply could not be evaded or overlooked. Even the need of "coordination," the blackest of the beasts which threaten the research scientist, became evident as soon as the war imposed pressing requirements which an unplanned, uncoordinated science could not meet. The knowledge that our enemies had succeeded in so organizing their

research and development programs that they had "got the jump" on us in numerous ways persuaded even reluctant individualists that coordination was absolutely necessary.

The war emergency also revealed the lack of balance which obtains when science is directed by chance. Many fundamental problems, upon which other inquiries depended, had not been touched and efforts had suddenly to be made to straighten the front. If this was borne in upon those scientists who participated in war research, it became even clearer to those who through lack of organization were left out. There are now many biologists who would sacrifice their cherished individualism for the sake of being identified with a great national effort. They realize that the neglect, the omission almost, of biology and biologists from the hastily improvised war agencies was bad not only for biology and for other sciences, such as the medical and agricultural sciences which depend upon biology, but for the Nation. Their state of mind is not improved by the reflection that, by and large, the fault was their own.

Still other changes in the attitudes of scientists are due to the growing realization that research workers need to recognize the connection between their own special work and the general scientific structure in which it will find its place and its function. It is difficult for the research worker to envisage this larger field without inquiring too about the still wider frame of society in which science operates. Many more scientists than formerly now believe not only that this social awareness of the men who do the work of science is needed to make a social being and a citizen of the scientist, but that this is essential in the national interest. Those who so believe will want to face the questions involved in the public support of science.

By these paths we come to the problem itself: What public policy toward science would encourage the best growth of science and its use for the welfare of the people? The aims of policy must be to reconcile two basic requirements, about which there is probably general agreement.

(1) Science and scientists must be free to grow and change in ways determined in part by the discoveries of science itself. This is the way in which science has progressed in the past—and the autonomy of small groups and the feeling of freedom of the individual to follow the new idea wherever it may lead are goods which must be preserved. This freedom must be accepted and guarded as a matter of principle; and provisions for freedom of publication and the prevention of arbitrary censorship must be a part of the basic policy.

(2) The forms of support and organization of science must be determined by social needs and purposes and are therefore matters of concern not only to scientists but to Government and to the ultimate beneficiaries of science, that is the people, as consumers and workers. Those who most directly need and use the results of scientific research in education, industry, agriculture, medicine, and public health have a special interest in the development of science, and means must be provided by which this influence can be exercised. The two primary conditions should therefore be: (a) A central organization by which the conduct of science is made responsive to public requirements and needs; and (b) the representative character of the directing agency or agencies, insuring democratic methods of administration.

These two requirements of autonomy, on the one hand, and subservience to social needs, on the other, have seemed antithetic to some, but I do not believe this need be the case. There is much evidence of the vitality and progressiveness of science in other countries where it is largely under public control. The extreme example of public control is in the Soviet Union, where the direction of scientific research is centralized in the Academy of Sciences, through which the support of the state flows to all of the research agencies. Other European countries occupy positions intermediate between this maximum and the minimum reached in the United States, where almost alone among modern nations science has retained a predominantly private character. Even here, the wartime activities of the Office of Scientific Research and Development and the Committee for Medical Research show that no essential incompatibility exists between research and public control; while the long peacetime history of United States Government scientific departments and especially of the Department of Agriculture illustrate the feasibility of accomplishing at once a scientific and a social purpose.

Much experience in the United States and in other countries indicates that, to obtain the maximum results from a given effort in scientific research, the interests of the research workers themselves must be consulted, but that these are not fundamentally different from those of the community around them. Scientists traditionally are primarily devoted to their work, often sacrificing other

interests to it and excluding other interests which tend to interfere with it. Yet, as the war shows, they will voluntarily and gladly place this devotion and their technical ability and intelligence at the service of an objective which is clearly defined and compelling. On the other hand, directing agencies, public or private, do not grudge to the scientist a greater measure of freedom than to other workers, provided they are assured of his adherence to the principles of service and to the general purpose which they consider essential, and that this freedom actually produces the results expected from it. Freedom within a general plan is a practical ideal at which to aim, as the comparative freedom of local political units within the general frame of Federal Union of the United States shows.

Voluntary cooperation of scientists with public agencies in the planning and execution of research would seem to provide the soundest base. The greater tendency toward teamwork and pooling of ideas by groups of scientists, the distribution of responsibility and credit for scientific work among the whole staff of a laboratory, the greater diffusion among younger scientists of the sense of social responsibility and the resulting tendency for social incentives to supplement more purely personal motives—these facts all indicate that it is reasonable to expect that scientists can and will participate in formulating the plans they will execute. This leads to the kind of self-government to which democratic administration tends, and which industry has found valuable as an incentive.

A further question that policy must meet is the ultimate disposition of the new knowledge which accrues from science. In the large segment of scientific research under private control, it is generally agreed that the ownership of valuable processes arising from research is to be vested, not in the individual scientist, but in the laboratory or the industry which has financed the research. Patents, therefore, generally become the property of the corporation by which the scientist is employed.

The question of ownership has already arisen concerning values accruing from war research, and it must enter inevitably into all plans for the future support of science.

The clearest basis for policy in this regard is that research done for a social or public purpose must be brought as quickly as possible to serve this purpose. If it is carried out for the public and at public expense, it should belong to the public; and there is no more direct way of making it public property than by publishing it as soon as the facts are clear. Publication would preclude patenting and, with certain precautions to be discussed below, would prevent the results of public science from becoming private property. But, by the same token, the results of private science would remain private, subject to patent or other ownership rights and restrictions.

A division of this sort already exists. Most agricultural research in the United States is done at public expense and results are freely published and can be consulted and used by anyone. The greatest change in American agriculture in the present century, the introduction of crossbred or hybrid corn, resulted chiefly from cooperative research between the United States Department of Agriculture and the State agricultural experiment stations. The results were quickly utilized by private seed companies, none of which was able to obtain a patent or found a monopoly on it. Crossbred corn therefore came very quickly into general use and its benefits were soon spread over all agricultural communities.

Side by side with this development, it was possible for private individuals and corporations to produce and patent new varieties of other plants, such as roses, which could be propagated asexually. The ownership of new rose varieties is thus (in general) private; but the new method of corn breeding belongs to the public.

The question of property rights need then be faced only when new values are created by publicly supported research; and the basic policy stated above—that is, free publication of the results of public research—need not interfere with existing arrangements under which private research operates. As a matter of fact, the more fundamental the research in the sense that the more general the truth that arises from it, the less will property questions arise. It is hard to find a patentable value in the general theory of relativity, or in the periodic system of the elements, or in the theory of the gene. It is the fate and the function of such ideas to become common property, and no man-made rules should be allowed to interefere with their free circulation. It is usually only the specific applications of general ideas which become subject to property restriction; and public policy can only aim at preventing such restriction from interfereing with the advance of science or with the spread of the benefits to the people.

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It is time now to deal briefly and in bare outline with the last question: How can these ideas and hopes about the support of science be brought into practical operation?

It seems evident that there must be an agency having as its chief concern the preservation, advancement, and diffusion of scientific knowledge. There are, in the United States, dozens of organizations having this aim in limited spheres, but that not one of them fulfilled the required functions in the national interest became evident when, in the war emergency, a wholly new and temporary agency, the Office of Scientific Research and Development, had to be created. The importance of the work assigned to this Office, and the powers and facilities which accompanied the responsibility, pointed not only to the need but to the method of meeting the need for a central agency of Government concerned with science.

It is probable that nothing less than the creation of a Cabinet Department of Science under a Secretary of Science can permanently meet the need. It ought to be connected directly with the central executive body of the Government, because only in such a position can it be made aware of the basic problems which face the Nation, and only through the political power which attaches to Cabinet rank can it gain the means and facilities with which to support the study of both and immediate long-term problems.

The structure of such a department may well be different from that of other Government departments because, in addition to policy-making and administrative functions, it would have to serve as a coordinating agency for many existing scientific agencies, both public and private. To name only two groups of interests, it would have to be closely connected with the universities and research institutes, and with industry, since in each of these institutions needs for new knowledge are likely first to become apparent, and from each flows scientific and technical information which can be put to use in national defense and development.

At the heart of such a department could well be a board or council of scientific research which could act at once as a granting agency, allocating funds for specific researches, and as a board of strategy, seeking out neglected areas, mobilizing disparate facts and distant persons, and shifting its forces from time to time to explore new avenues of research. If it fulfilled its best purpose, it could not be content to sit and sift, but would itself have to search and ponder in a more active way. Its basis of operation as a granting agency might well be patterned upon the Office of Scientific Research and Development in that it might receive applications for research funds from universities, research laboratories, other Government agencies, or even individuals, and might enter into contracts with those it judged as offering the best prospects for needed scientific advance. Like OSRD, it might find no need to become an operating agency with plants and facilities of its own, although it should have some freedom to use those methods best calculated to promote the best research.

Much would depend upon the composition of this board. It should consist of working scientists who can judge the merits of various research proposals and policies, and of representatives of those for whose benefit the research is done and who in the end pay the bills, that is, the public as represented by labor, consumers, and industry, small or large. Perhaps a proportion of eight scientists and four public representatives would express both the purposes and responsibilities of the board; and some of the scientists should be drawn from, or be primarily interested in the scientific work, of the Government departments.

Since there should be no disposition on the part of such a board to displace any existing research agencies, but rather to supplement and aid them, its most important function might well turn out to be, especially in its initial operations, that of coordinating and facilitating research generally. It would undoubtedly avoid competition with industrial research, and direct its first attention to "unprofitable" fields such as exploration looking toward new natural resources, housing, public health, etc. It would probably be concerned with such public services as the provision of adequate means of publication, of bibliographic and library services, of abstracts and translations of foreign scientific literature and similar functions.

Either this board or another one in the Department of Science would of necessity concern itself with one of the basic questions in all scientific research: how to insure an adequate supply of trained scientists for research, for education, for industry and for public service. Its operation in this respect could well be patterned upon the fellowship boards of the National Research Council, which at present administers limited and temporary funds supplied from private sources.

Two main criticisms to the proposal outlined above may be anticipated. One is that research cannot be free under a central direction, but will wither and die.

Scientists, it is said, will not submit to regimentation, nor can new ideas, the life-blood of science, be created by subsidy. The other criticism is that the needs are already met by such existing agencies as the National Academy of Sciences and the National Research Council.

The first criticism is certainly a cogent one when central control is proposed, but it applies with less force to a board which judges applications initiated by working scientists as individuals or groups, especially when many of the judges are themselves working scientists who know how delicate a plant original research is and how necessary is the atmosphere of freedom to its growth.

Much will depend upon the degree to which members of the board realize that any organizations of this sort exists primarily to provide a material body for the mind of science. There are scientists and others who know this and who apply to organizations proposed for science two essential criteria: Does it provide the mind with adequate and proper facilities? Does it leave the mind free to strike out in new directions? Men who ask these questions are the ones whose sense of public duty would bring them into the service of such a board, just as it brought such men into the direction of war research.

In regard to the second criticism, it must be pointed out that in the war emergency neither the National Research Council nor the National Academy of Sciences proved to have the character needed for an agency to guide and administer the organization and support of science. Neither is an operating agency; and, as constituted at present, neither could provide the initiative and the administrative services which are required. The relative isolation in which they have functioned has removed them from that close connection with problems of public policy so essential for an agency to have which is to be responsive to public needs. They have the confidence of scientists and close connection with academic research and with the scientific societies and organizations and are thus well prepared to serve an important advisory function. The National Academy of Sciences, as a council of elder statesmen, could well be called upon to pass upon the qualifications of scientists proposed for membership in the Board of Scientific Research. The academy would be less able to maintain sufficiently close relations with consumers, with labor, and with industry, and it would be less competent to advise on questions bearing on the social relations of science in these fields.

The board might conduct its relations with the scientific societies through the National Research Council, which could then be incorporated into the Department of Science and carry out other important functions, such as maintaining a permanent roster of scientific personnel.

It is, of course, possible that the academy and the present National Research Council might be so changed as to assume the functions it is proposed to assign to the board. The changes would be so fundamental as to constitute conversion of these older organizations into a new department of the Government; and it is probable that the traditions of both institutions would make such conversion a slow and difficult process, for, in spite of their "national" character, neither has felt itself to be a truly public agency.

In this brief sketch it has not been possible to indicate what the relations of the new organization would be to existing scientific departments and bureaus of the Government. Some, like the Bureau of Standards, would probably become a part of the new Department; others, like the Department of Agriculture, are already so important as to require separate existence and budgetary independence, although certain of their research functions could well be assumed by the new Department. But these and many other questions will require thorough study and discussion both by scientists and statesmen.

Finally, as scientists, we may ask what practical steps we could take to hasten the consideration of questions about the organization and support of science. One suggestion arises directly from the fact that, as scientists, we have no over-all organization to bring our views on such questions to a focus or to represent our interest in public matters, or to permit our influence to be brought to bear upon problems which affect the scientist. Perhaps we should have a guild or a federation of scientific societies which could concern itself with such questions.

As scientists, we might also encourage and cooperate with those statesmen who have seen the need and have begun to study the problem of the public support of science. Too frequently we have remained aloof or have opposed even the public discussion of the problem. Apparently we have still to learn that there is a politics concerned with policy, and that only through such a political channel can science come to occupy its rightful and necessary place in the state.

Senator MAGNUSON. At this point I will make a part of the record the prepared statement of Dr. Lawrence S. Kubie, who testified briefly on Tuesday.

(The material referred to follows:)

PREPARED STATEMENT OF DR. LAWRENCE S. KUBIE, NEW YORK CITY

Psychiatric research cannot be sharply isolated from medical research in general. In its organic aspects it leads into every detail of both the basic and clinical medical sciences. On the psychological level it involves every aspect of the social interplay between men, such as the effects of race, culture, and climate, of economics, of population density, of occupation, etc. Much of this consists in the application of psychiatric knowledge to social problems. Basic research in psychiatry consists primarily in the search for the causes of illness and for its therapy. In seeking Government support for psychiatric research we wish to place emphasis on the need to support investigations all along the line from the most basic, to those practical applications which are of vital importance to the health of our democracy.

A few years ago Dr. George Stevenson, for the National Committee for Mental Hygiene, made a survey of the funds being used for psychiatric research in psychiatric hospitals throughout this country. For many reasons it was difficult to establish this with precision. Funds for support of general clinical activities and funds for research were not always clearly defined. However, a generous estimate was that the total amount invested in psychiatric research in the country as a whole at that time was about $350,000 a year.

For the sake of comparison let us look at the figures for research in other fields. According to statistics from the Department of Commerce in the same year, $275,000,000 was being invested in industrial research; and a compilation indicated that our research foundations in that year were investing $5,000,000 in general medical research, of which somewhere between $100,000 and $200,000 was earmarked for psychiatry. In the same year the Veterans' Administration was investing $25,000 in research in psychiatry, less than the cost of maintaining one veteran for life in a psychiatric hospital.

In other words if we take the amount invested in psychiatric research as a unit of 1, then general medicine would be represented by 50, and industrial research by 2,500: i. e., 2,500 times the investment in psychiatric research for that year. When one considers the incidence of psychiatric disturbances this position of psychiatry as the stepchild of medicine becomes all the more disturbing. To make this point clear I must draw your attention to a few well-known statistics.

Our current mental hospital population is approximately 600,000. There is another approximate 600,000 on parole or in remission, a total of 1,200,000. This means that one out of every hundred individuals in our population at some time in his life becomes a patient in a mental institution.

The mental defectives cared for in institutions in this country total 100,000. It is carefully estimated that mild degrees of mental defect are cared for in the community in much larger numbers, to the astonishing total of 2,500,000. Approximately 1 in 50 in our country has some degree of mental deficiency.

The psychoneuroses are variously estimated as running between 3,000,000 and 6,000,000—or 1 in 25.

Summing this up we find that seven American citizens out of every hundred presents himself at some time in his life for psychiatric treatment.

It is not surprising, therefore, that in 1923 neuropsychiatric problems constituted 39 percent of the problems with which the Veterans' Administration was confronted; and that in 1938 these same problems constituted 58 percent. The total neuropsychiatric hospital load in the Veterans' Administration rose from 5,000 to 33,000 between 1920 and 1940.

The validity of these figures for the over-all incidence of psychiatric problems has been demonstrated by the experience at the induction stations in World War II: 1,825,000 young men were rejected on neuropsychiatric grounds for service in our armed forces in World War II. Calculated against the total number examined, this comes close to the statistical estimation of the incidence of such disorders given above. In spite of this, 750,000 men have been discharged from armed forces for neuropsychiatric reasons.

How well equipped are we to deal with this problem?

We have about 190,000 physicians in the country, only about 3,500 of whom are trained psychiatrists. Furthermore of these about 2,800 are hospital psychiatrists, leaving less than a thousand to deal with all community psychiatric problems,

less than a thousand to run child-guidance clinics, general psychiatric clinics, to service general hospitals, to do the necessary psychiatric work for schools and courts, and to carry on private practice. In a study conducted by the National Committee for Mental Hygiene it has been carefully estimated that we need 15,000 psychiatrists to carry on community psychiatry and another 6,000 to carry on psychiatric hospital psychiatry.

Evidently civilian medical education has failed the country, just as civilian medical education failed the armed services. Civilian medical education adds to the roster of trained psychiatrists not more than 50 to 100 men a year, barely more than the annual retirement rate for over age or illness. Furthermore there are only 400 approved positions for training in psychiatry in this country, not all of which are available in any one year, and of which only 50 are of first-rate quality.

This acute shortage in competent trained psychiatric manpower constitutes the worst bottleneck on adequate medical service in the country today. It constitutes the chief bottleneck in the whole rehabilitation program. Without more psychiatrists our rehabilitation program will remain nothing but plans.

A full consideration of this problem would take me somewhat afield from the major purpose of this testimony. However, I must emphasize the fact that you cannot carry on research without trained personnel; and that in this field the shortage in personnel is so great that we cannot divorce a program of research from a program of training. I would like to add that it is possible to work out a plan whereby this bottleneck can be steadily relieved. Such plans have actually been devised. In the returning medical officer we have a reservoir of manpower today which could be trained in the next 2 or 3 years. But this reservoir is leaking away rapidly and unless prompt action is undertaken, a golden opportunity to solve this problem will be missed. I cannot go into the details of this plan here or at this time; but I hope that an opportunity will arise to present it before the appropriate committees on some other occasion.

Much could be said about the human and economic waste involved in psychiatric illness. Psychiatric illness lasts a long time without killing. The patient remains dependent upon the community for many years. He is lost to himself, to his family, to his country, and to industry. Computing the cost of such illness is a sobering task. There is the cost of caring for the man, of caring for his family, the cost of the illnesses which his illness breeds in his wife and children, and the cost of replacing him in the industrial system. The Veterans' Administration figures that it cost the country about $40,000 for each man who has to be kept as a mental patient throughout his life; and this takes into consideration only the first of these considerations, namely the cost of custodial care for the man himself. The total cost to the community for each man would come close to $100,000. This should be kept in mind when one considers investment in research and training in the field of psychiatry. There is no investment that I can think of which will pay off better in mere dollars and cents to the taxpayers of this country. We must train more psychiatrists, more clinical psychologists, more psychiatric social workers, more psychiatric nurses and attendants. These are all essential links in the research team, as they are in the therapeutic team.

For us you will see then that the war has just begun; and we turn to you for assistance to wage this war because we need more money than States or private sources can supply, and especially more unrestricted long-term research funds, more coordinated researches, more facilities for training mature men, and especially, as I have said, for training the returning medical officer.

We would like you also to consider the fact that Federal aid is actually essential for several reasons. Among these is the increasing cost and duration of training. Most students in postgraduate psychiatric training are of necessity mature men with families. You cannot make psychiatrists out of children. In one training institute in New York the average age of the student body is 35. They require support, yet private sources of funds are decreasing and will continue to decrease.

Federal aid is needed in order to stimulate and activate work in the educationally backward parts of the country, where psychiatry is nonexistent, by supplying funds, by setting standards, and by supplying the trained personnel which is lacking in those parts of the country. Furthermore, Federal aid can have certain positive advantages. It can make it possible to coordinate and compare work in various centers and in various parts of the country, in varied social, economic, and cultural areas, and with varied national stocks.

Second, it will insure a steady flow of new knowledge to Federal, State, and local governments, to national defense, to management and labor, and to education.

Thirdly, it can reduce the present tendency toward an increasing competitive scramble among young men for posts, and among institutions for funds. This

scramble has unfortunate effects. It leads to short-term piecework jobs, research carried on with one eye on the annual report. Effective science cannot be run in this way. We need long-term, 5- and 10-year programs. It must be remembered that 99 percent of the work of science is humdrum, pedestrian, and obscure. Only the last job, the finishing touch which makes something useful has any dramatic public appeal. Work which is done with one eye on the newspaper is rarely sound. Work which is done with one eye on a private board of trustees suffers from the same difficulty. Scientific work must be carried on in an atmosphere of security, with the knowledge that funds are available through the lean as well as the full years, and without much thought of those rare dramatic climaxes that come after years of undramatic work. For all of this, Federal aid will be both essential and advantageous.

Above all, however, I would emphasize again the fact that although the span of human life grows longer, the period of training and apprenticeship grows even longer still. This creates serious economic problems in the lives of all young scientists. They have too short a period of scientific maturity in which to establish themselves with the dignity and peace of mind of economic security. They cannot be sure of giving their children the same quality of education as they received. Unless we have Nation-wide support of science there is a danger of science becoming a rich man's club. This we can never allow to happen.

Before closing I would like to say a few words about the bills which are under consideration from another point of view. I do so with some hesitation, because I am well aware of the limits of my own competence. I make no pretense that I know the final answers to the difficult problems of administrative law which are involved, many of which have been ably discussed by my predecessors here today and at previous hearings. Nevertheless I would like to say a few words about secrecy, about patents, and about organization at top levels. I presume to do this because each of these three factors profoundly influence the intellectual and spiritual atmosphere in which the scientist lives and works. Perhaps as a psychiatrist I may presume to say a word about them from this angle.

If there is any one thing which has characterized American and British scientists it has been the spirit of open yet friendly rivalry which has permeated our scientific institutions. A subtle balance has existed between frank competition and readiness to exchange mutual aid and assistance between men working in the same fields. To an extraordinary extent there has been spirit of good sportsmanship. No one will doubt that this is one of the sources of the greatness of our scientific activities; and the proposed legislation must be carefully weighed to be sure that it does not endanger this source of our greatness.

Perhaps I can best make the point clear by pointing the lesson for you from the experience of our recent enemies.

Everyone who has followed the course of German science since the turn of the century has watched its slow deterioration. This has been true in many fields, and long antedated the appearance of Hitler. We have the testimony of many eminent German scientists to this effect. Furthermore, we have their testimony that it has been due to two things: The creation of a rigid and dictatorial scientific hierarchy, and the growth of a general atmosphere of secrecy and of mutual distrust among German scientists. It was a shocking experience for Americans who went to Germany to find that laboratory doors were locked. No one of us has ever seen a locked door in an American laboratory, nor for that matter, in England. In Germany scientists never sat around tables together swapping their experiences of trials and errors, telling of how their work was going, asking each other for suggestions. There was too much fear that somebody would steal the work. And in fact Americans have returned with the story of having talked with characteristic freedom and confidence, only to have their work plagiarized. Let us not let secretiveness enter our scientific councils by any back door.

Or, take the problem of patents. Not many years ago Prof. John J. Abel, the well-loved professor of pharmacology at Johns Hopkins, made a discovery which was a turning point in medicine. He had isolated the active principle of adrenalin, the first time that the active principle of any gland of internal secretion had been isolated. At that time a Jap was working in his laboratory who proceeded quietly to make a slight chemical modification of the essential principle which Dr. Abel had discovered. This he patented. Ever since then every bit of adrenalin that has been used, has paid tribute to that Japanese patent. This might well be compared with the practice which exists in so many American laboratories today, whereby if the products of research are patented, the returns go not to the individual but to the laboratory. Let those who claim that patent rights are a necessary incentive to the scientist consider this example carefully.

Personally I must conclude that science cannot live in an atmosphere of secrecy, distrust, suspicion, or of exclusive private gain. Perhaps I would be justified in saying that nations cannot live in such an atmosphere either. Again, as a psychiatrist, I would remind you that whenever science goes underground it creates anxiety. If science is to allay public fear and avoid misinterpretation, science must always be open and aboveboard. Obviously this brings us to a complex problem in national policy. But I would suggest that if those in charge of our national defense feel forced to be secretive, whether this is about atomic energy or anything else, let us not delude ourselves about the universal effect of a policy of secrecy both internally on our own scientists and externally on international trust and good will. A policy of secrecy taken for purposes of defense may well lay the rails of distrust that lead to war.

Finally, I would say a word about the problem of top leadership. This has many aspects; but I will discuss only one, namely, the problem of human frailty. If human beings were not frail, there would be no problem. Then we could set up this foundation in any way, and it would work. Organizational problems arise in the effort to protect human beings from administrative tyranny, and from the errors arising from the prejudices and biases of those in authority.

We must admit that scientists share all human faults. Claude Bernard pointed out the fact that they work with the same prejudices, antipathies, intuitions, and guesses that every other man uses. It is only in their fields of special scientific competence that they school themselves to test and check their biases by experimentation. Outside of their special fields they are likely to be as full of prejudice and emotion as is every other man. How does this affect the organization of a national research foundation? How will this affect—that is, the functioning—at top levels? Here we have to ask, What decisions will be made at the top level, and how will bias enter into them? It seems to me that the most important decisions will be those having to do with the allocation of funds and personnel. Here obviously freedom from bias is essential. As a psychiatrist, I feel strongly about this point, because psychiatry throughout the world has been impoverished by inadequate support of neuropsychiatric research and teaching; and in this it is human bias which has limited funds, space, and the allotment of personnel to psychiatric departments in our schools. I cite this only as an example. The ability at the top level to adventure into new and unfamiliar fields is of basic importance and will be determined by our ability to free the top levels from the influence of such biases.

I am not going to propose any easy solution to this. I am only going to say that the choice of the type of organization should keep this problem in mind. In general it is true that the best way to limit the effects of bias is to balance individual bias by having more than one person participate in every decision. This might mean some form of commission government, representing disinterested lay as well as scientific thought, with a small appeal board of laymen and scientists who could intervene and act in a judiciary way whenever an impasse arose, might provide as close an approximation to a bias-free system of control as could be set up. No such machinery will always work perfectly; and to safeguard the freedom of the scientists, and to insure freedom from bias, some adequate appeal machinery should be created.

This has been suggested in the testimony of both of those who have immediately preceded me here, and I wish to support the more specific and detailed suggestions which they have made in this connection.

Senator MAGNUSON. Has anyone else anything further to suggest? Thank you, gentlemen, very much for coming down. You have made a great contribution to these hearings. I hope we can agree to all the ideas you suggested. Thank you very much.

(The hearing adjourned at 1:20 o'clock.)

HEARINGS ON SCIENCE LEGISLATION

S. 1297 and Related Bills

THURSDAY, OCTOBER 25, 1945

UNITED STATES SENATE,
COMMITTEE ON MILITARY AFFAIRS,
SUBCOMMITTEE ON WAR MOBILIZATION,
Washington, D. C.

The subcommittee met at 10 a. m., pursuant to adjournment on October 24, 1945, in room 457, Senate Office Building, Senator Warren G. Magnuson, Washington, presiding.

Present: Senator Harley M. Kilgore, West Virginia; Senator Warren G. Magnuson, Washington; Senator H. Alexander Smith, New Jersey.

Also present: Dr. Herbert Schimmel, chief investigator; Mr. John H. Teeter, director of hearings for Senator Magnuson.

Senator MAGNUSON. The committee will come to order. Dr. Compton, we will be glad to have you come up here, and Dr. Urey and Dr. Smyth, if you would like to come up and sit here, we would be glad to have you sit around the table with us.

Dr. Compton, I see you have a prepared statement. The practice here is to let the witnesses read their statements, usually without interruption, and then to ask what questions we have afterward. If you, for the record, would just qualify yourself as to who you are, we will be glad to hear from you.

TESTIMONY OF DR. KARL T. COMPTON, PRESIDENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. COMPTON. Senator Magnuson, I will proceed as you suggest.

My name is Karl T. Compton. I am a physicist by profession but have been president of the Massachusetts Institute of Technology since 1930.

From time to time I have had the privilege of serving various agencies of the Federal Government. In 1933 and 1934 I was Chairman of the Science Advisory Board. In 1939 I was a member of the War Resources Board. Since 1940 I have been a member of the National Defense Research Committee which, as you know, is one of the components of the Office of Scientific Research and Development. After Japan cut off most of our sources of natural rubber, soon after Pearl Harbor, I served as a member of the Baruch Rubber Committee. These were all Presidential appointments. In addition, I have served on several advisory committees to various departments of the Government, such as the Advisory Committee on the Weather Bureau, the Visiting Committee of the Bureau of Standards, and the advisory

boards to several of the military agencies. Not quite a year ago I was appointed Chairman of the Research Board for National Security, which was set up under the National Academy of Sciences at the request of the Secretary of War and the Secretary of the Navy, but this agency has not been activated principally, I believe, because it seemed likely that the provisions in some of the legislation which is now being considered by your committee, would make more permanent and far-reaching provisions for insuring a continually active and alert program of scientific research in order that our country might have the best protection from the field of science which could be secured. All of these services have been rendered without compensation from the Government and I merely mention this fact as bearing upon the question which is sometimes raised: "Will the scientists of the country offer their services freely to the Government when called upon?" The answer is definitely, "Yes" if the job seems to be important and if the conditions are such that a useful contribution can be made.

During this war my principal responsibility for the Office of Scientific Research and Development has been as Chief of its Office of Field Service, which was the agency created by OSRD to facilitate the introduction of new weapons and medical materials into use in the active war theaters, with the assistance of scientists despatched to these theaters to aid the armed forces in putting these devices or materials to effective use. I resigned as Chief of the Office of Field Service about 3 months ago to become Director of the Pacific branch of OSRD, located in the Philippines under General MacArthur's command but set up to serve all branches of Army, Navy and Air Force in the forward Pacific areas. After the surrender of Japan, I was sent up to Japan as a member of a small scientific intelligence mission, from which I returned just 4 weeks ago.

Because of this recent absence and the congestion of duties since my return I have not been able to follow as closely as I should have wished the deliberations of this committee, or to prepare as adequately as I should have liked for this hearing. I feel that the subject before your committee and the objectives of all of the bills under your consideration are of the highest importance for the future welfare of our country, and I wish to be recorded as being in wholehearted support of the basic objectives of stimulating in every possible way the development of scientific knowledge and its useful applications to health, industrial activity, standard of living, and national security.

These bills, now under consideration, spring out of a widespread realization of the value and usefulness of science, and perhaps their introduction at this time has been stimulated by the dramatic demonstrations of this value during the past years of war. No place have I heard any doubt expressed that the principal objectives of these bills should be realized. The problem before the committee seems more to be an embarrassment of riches than a poverty of ideas, and the big problem is to make the wisest possible selection from among the various ideas here represented into the form of an act of legislation which will be a sound basis for vigorous scientific development in our country.

It seems to me that the situation is analogous to that which we so often encounter in tackling promising new ideas. There is a long period of discussion and of uncertainty as to how to proceed but finally, if the idea is really good, there develops a meeting of minds

and a positive action which leads to results; and sometimes after the whole thing is done we wonder why we did not do it sooner. Eleven years ago, in the Science Advisory Board, a proposal was developed and submitted to the President for Federal support of scientific work. Nothing apparently came of this at the time and I think there were several reasons. One was that most of us had not become accustomed to thinking in those terms. Another was that the proposals then made were far less well thought out, less comprehensive, and less statesmanlike than is the sum total of the proposals now under consideration. An important feature is that we have now had 5 years of intensive national scientific effort under governmental coordination and support and have feared a great deal about proper procedures, necessary conditions for effectiveness, and possibilities of achievement. This would certainly seem to be the strategic time for action.

So many able witnesses have already discussed with you so many aspects of this proposed legislation that I am not going to even attempt to make a full statement of my ideas on the subject. Practically all of these have already been very well stated by others. I would, however, like to make first a few general comments on some aspects of scientific research which seem to me important as a background on some of these issues, and then I should like to express a few ideas on the particular subject of research for national security.

First, let me comment on the differences between fundamental scientific research and applied research. While they have a great deal in common, there are nevertheless some differences which are very important and which should be kept in mind both in the formulation of regulations and in the anticipation of results.

The very striking achievements of the last 5 years of intensive research organized for the purpose of winning the war, give perhaps the best example in all history of the power of applied research. Here, practically every job was undertaken with a specific objective in view. When every job was started it was on the basis of some plan or program which showed promise of leading to the desired objective. All known facts of science and of art that are applicable to the problem are brought to bear on its solution. The whole thing can be planned with greater or less certainty in advance. The plans do not always work out but they usually do, at least up to some degree of success. This is the approach which is characteristic of applied research, whether it be to industrial development or to military uses, or to improved medical practice.

The most important aspects of fundamental scientific research, on the contrary, cannot be planned with anything like the same certainty. This is, of course, because such research is aimed at finding out something which we do not already know and obviously nobody knows just what the results will be. When I was directing the research work of students in my days at Princeton University I always used to tell them that if the results of a thesis problem could be foreseen at its beginniig it was not worth working at. While, of course, every research project should be undertaken with as careful planning as possible, the more fundamental that research project is, the more likely these plans will have to be changed in the light of unexpected facts which turn up in the course of the investigation.

Here I would like to interpolate a comment which I think gives an analogy to this situation. When Columbus discovered America he

could not have laid out a planned program of developing the mineral and agricultural resources of the country, because he did not know what was there. When Hendrik Hudson went up the Hudson River he hoped he was finding the Northwest Passage, and it was only after these explorers, La Salle, and others, had gotten around a bit over the country, their various theories of the layout of the country could be put together and we will say a master theory developed as to just what this country of America was.

That was continually refined by further exploration, and later the mineral resources and agriculture possibilities and all of those things came out and I think exploring fundamental new scientific territory is very much like that. The success depends upon the quick putting together of all of the information that is gained by various people and coordinating that, getting the fundamental picture from all available sources. Going back now to the prepared statement:

The most important prerequisites for success in fundamental research involve such things as the following: Choice of a field of research which appears rich in possibilities; selection of some specific project in that field which will open up a path into its unknown frontiers; availability of suitable laboratory facilities and equipment needed for the work; above all, research personnel of imagination, originality, analytical ability, and sound training and skill. Of the utmost importance in opening up a great new field of science, like nuclear physics, or electronics or the understanding of physiological processes, is the greatest possible opportunity for exchange of ideas and information and mutual stimulation among all the workers in that field. This is the principal reason why discovery of fundamental facts of nature has never prospered under conditions which limit the free exchange of ideas—conditions such as patent consciousness, trade secrets, and military security.

An excellent example of the way this works is given by the history of the development of the radio tube. This development extended back at least a hundred years. For at least the last 80 years there have been hundreds of articles written and thousands of workers on observations and theories in the process of coming to an understanding of the basic scientific facts which are here involved. From time to time theories or observations were wrong but most of them added a little to the sum of previous knowledge. Then occasionally some lucky genius would make a generalization which would formulate some new law of nature, such as that governing the emission of electricity from a hot filament, or the passage of electrons through a vacuum. Then at some stage in the game an inventor comes along and sees a practical application, and out of this come the various types of radio tubes. The great industrial laboratories have shown great skill in making the practical applications of these ideas in the form of operating equipment of high efficiency and usefulness. These planned programs of application in the industrial laboratories are applied research and can be carried on with systematic planning and with definite objects in view, but the gaining of the basic information would have been greatly retarded and perhaps never achieved at all if it had been carried on in an atmosphere of patent consciousness or restriction in professional intercourse between workers in the field.

Research scientists know by experience that these are the ways in which they can make progress in their fields, and this is the basic reason why they are so unanimously asking for the maximum opportunity for those things that can be lumped together in the phrase "freedom for research." This is one of the main reasons why I prefer S. 1285 to S. 1297, in that S. 1285 allows greater flexibility by the National Research Foundation in handling any patent equities in accordance with the requirements of the various types of situation which we know will arise. Every such situation should be handled by the foundation in the manner best calculated to serve the public interest, but I do not believe that any single or very simple set of rules can be set up in advance for achieving this result without acting to the detriment of the main objective of the bill, namely, advancement of scientific knowledge. Consequently I believe that the statement of policy or objective for handling inventions in the public interest is about as far as the bill should go, and that the foundation itself should meet the various situations as they arise in accordance with this policy. These considerations—that is for freedom of exchange of ideas, patent considerations and so forth—apply not only to certain aspects of the bills before your committee, but they also apply to the bills in respect to the development and use of atomic energy which have been submitted by Mr. Johnson and Mr. May and which are under consideration also at this time.

It has occurred to me that we can draw some useful conclusions by looking backward over a somewhat analogous situation, the development of the automotive engine and its applications in the airplane, the tank, the bulldozer, the automobile, and so forth. Suppose, about the time when most of us were boys, and the automotive engine was relatively in its infancy, some agency like the War Department had conceived the idea that this might be very useful as a future military development and had clamped down the imposition of secrecy in the further studies of high-octane fuels, metallurgy, thermodynamics, and engine design, and all other features which have to go to build the most efficient possible engine. These conditions of secrecy might have involved a prohibition against doing work in this field without a license and against any discussion with other workers in the same field except by Federal permission, and no right of publication of results unless this commission thought that they would be of no aid to any foreign government. We can easily see what the results of such a policy would have been. Our own development of the automotive engine and the great automobile and aircraft business would have been greatly retarded in this country. Other countries operating without such prohibitions would have forged far ahead of us. When this world war broke out we would have lacked what was perhaps our greatest asset, namely, the great industrial know-how and productive capacity which enabled us to throw overpowering amounts of mechanized equipment into the field, saving an enormous number of lives of our own troops, and enabling us to deal overpoweringly crushing blows to the enemy. In a similar way, with any development of an important new field of science which may have important practical application for either peace or war, it seems to me that our first consideration for national economy and national security must be to handle this development with a minimum of inhibitions and a maximum of assistance and inducements,

so that as a result we will be in a position of outstanding power in this field, and all this can be done on the basis of sound peacetime objectives, with military applications playing only a subordinate role, as they did in peacetime all throughout the period of development of the automotive engines and their uses.

My second comment has to do with the educational aspects of S. 1297 and S. 1285, considering education in the broad sense to include also the research which goes on in educational institutions.

For something like 80 years, if I remember correctly, the Federal Government has assisted in the development of programs of higher education in the various areas of the country through its system of grants to the land-grant colleges, primarily for agriculture and engineering or mechanic arts.

This Federal support has been of enormous value, particularly in the newer sections of our country. It has established strong educational centers long before the time when the economic resources of those areas would have justified the expense. Yet I am firmly convinced that over the period of years these costs to the Government have been justified many times over.

I have long thought that this program of Federal aid in education should be supplemented by a second program aimed not so much at spreading educational and research facilities over geographical areas of the country as at focusing on important scientific or technical objectives. Such a program, for example, would consider one after another of the most important industrial or agricultural or economic problems of the country and support a constructive attack on those problems at the places and with the personnel which show specially good promise of bringing about the desired results.

These two forms of Federal support of education and research may be likened to two important types of operation in aerial warfare. The one is area bombing aimed at bringing about desired results over a given area, and the other is pinpoint bombing, aimed at striking very specific objectives. Except for the fact that Federal support of education and research are aimed at constructive rather than destructive objectives, we may say that the program of Federal aid to land-grant institutions is analogous to the area bombing, whereas that type of aid which will be possible under these bills is analogous to the pinpoint bombing. I think both are highly desirable and in fact necessary to the best development of our country.

While on the subject of education I would like to say a few words in high endorsement of the provisions of S. 1285 for fellowships and scholarships in the various scientific fields. Every educator knows how important such aid is in the development of highly promising young men and women who might otherwise find it financially impossible to secure an education commensurate with their talents and promise. I think most scientists would agree with me in saying that there was no influence in raising the United States from a third-rate position in science to the first-rate position which was so effective as the program of national research fellowships put into operation immediately after the last war and administered by the National Research Council with funds provided from the Rockefeller Foundation. An astonishing proportion of the top positions in American science are now held by men who had the benefit of these postdoctoral

fellowships. For example, in the organization of the Office of Scientific Research and Development a large number of these men held positions on the committees, or served as technical aides, or directed or otherwise held prominent positions in the most important research projects. It would be invidious to mention these by name, but just by illustration I would say that the three men who headed the three great scientific establishments which developed the atomic bomb were all former National Research fellows. They were Dr. J. R. Oppenheimer, Dr. Ernest Lawrence, and my brother, Dr. Arthur Compton. Also, Dr. Henry Smyth who wrote the Smyth report on atomic energy was another one of these fellows. I could also mention Dr. DuBridge who headed the great radiation laboratory which was the center of microwave radar development, and Dr. P. M. Morse who headed the operational research group for the Navy Department, or Dr. George Harrison who first established the Research Section in the southwest Pacific area. These National Research fellowships were provided by the Rockefeller Foundation to give a boost to American science at a time when this boost was very greatly needed, namely, immediately after the First World War. This is only one of a number of important fellowship programs which have been established by private foundations, and I think the experience has been such as to justify high hope now for an even greater usefulness under the operation of this proposed legislation. I think the usefulness can be greater because the need is greater, the opportunity is greater, and both now considerably exceed the possibility of adequate handling by private philanthropy.

Finally permit me to comment on the provisions of S. 1297 and S. 1285 which provide for scientific research in the interest of national security. I am glad to see that in the revised S. 1285 the essential aspects of H. R. 3440 have been incorporated.

One of the most important and effective achievements of this war has been the extent to which the military and scientific forces of the country, in which I would also include the industrial producers, have effected a working partnership. In this we have gone way beyond our totalitarian adversaries, Germany and Japan. In Japan, for example, we found such partnership to be almost totally lacking, and in fact we found in its place mutual jealousy and distrust. For our future national security it is important to keep this partnership alive because it did not spring up over night, it gradually developed as each group came to understand the problems, realize the competence and come to trust the other.

One of the outstanding illustrations of this was the situation in which I was recently involved in the Philippines. Here, under General MacArthur's command, there was established a Pacific branch of OSRD, reporting directly to the Chief of Staff and occupying a position in parallel with the Sixth or Eighth Army, the Seventh Fleet, or the Far Eastern Air Force; yet it was a civilian organization depending on the civilian laboratories of OSRD back in the United States for personnel, equipment, and advice. The plan was developed over several years of experience and growing mutual acquaintance. This kind of partnership between the scientific and the military groups is a thing which should not be lost but should be continued and cultivated as a permanent element in our national defense.

By this partnership we do not, of course, mean that military men have become expert scientists, or that the scientists have become expert military strategists. It does mean, however, that they must be acquainted with each other and with each other's problems; that the scientists should, as a matter of national duty, devote some of their attention to solving the technical and tactical problems of the military and the military should be kept abreast with scientific developments so that they can plan their equipment and operations to take fullest advantage of every technological possibility.

Both S. 1297 and S. 1285 are aimed at continuing and supporting this productive partnership. In this respect I believe that the provisions of S. 1285 are more advantageous in that they definitely combine the two features which were found by experience during the past 5 years to be most advantageous. These features are first, a small responsible committee in charge of the scientific program which is formed predominantly of scientists or engineers, but on which the armed forces have representation through which the needs of the various services and the opinion of their technical bureaus can be expressed; second, a larger advisory body which presumably would be comprised of top-ranking officers of Army, Navy, and Air Forces, together with prominent scientists, engineers or industrialists who would be kept informed of the program, could suggest policies or directions in which emphasis should be placed, and who generally could serve both as an educational medium for their respective groups and as a coherent group comprising enough men in strategic positions to make it possible at any time of emergency to expand greatly the scope and cooperation between civilian and military on technological matters.

In conclusion, let me summarize my principal views on the bills before your committee. S. 1248 seems to me to be primarily concerned with matters within the Department of Commerce. Insofar as it would plan to deal with matters on a broader scope, I should prefer very much to see them handled under the provisions of S. 1297 or S. 1285, because I believe that either of these bills would provide a stronger and sounder framework for national scientific development.

S. 825 and H. R. 3440 refer exclusively to scientific research for national security. Either of them would I think have been a distinct step in the right direction. However, the essential aspects of both of these seem to me now to be incorporated in S. 1285, and I believe that there are strong advantages in having this national security aspect made part of the larger program.

S. 1297 and S. 1285 are very similar in objective and general concept. Of the two, I am convinced that S. 1285 contains the sounder provisions wherever they differ. The more important differences seem to me to have to do with the basic organization of the foundation and the matter of handling patents.

As to organization, I believe that the vesting of the authority in a small commission would be both more effective and safer than vesting the final authority in a director. The program contemplated is too great and varied in scope and too important in its consequences, in my judgment, to be entrusted to the final authority of one individual. By long experience I have come to have great faith in the combined judgment, knowledge, and wisdom of a small competent group—far

greater faith than in the ultimate decision by one individual. Furthermore, I am certain that the members of the foundation itself would take a much more responsible and helpful part in the work of the foundation if they had the responsibility, than they would if they were solely in an advisory capacity.

I have already commented on what I believe to be one of the weaknesses of the patent provision in S. 1297. I have two further criticisms of these provisions. One is the fact that they would seriously limit the opportunities of the foundation and obstruct the possibility of useful and much needed assistance by the foundation in many important projects. I think this would be true almost universally in the very important and necessary work of the industrial laboratories, but it would also be true to a very considerable extent in the laboratories of educational institutions—I might also add of small companies. The other objection to these patent provisions is the fact that, if they are to be enacted at all by Federal legislation, it seems to me that they should be enacted separately from this bill and put into another bill applicable to all use of governmental funds in all agencies and enacted only after full hearings by all concerned. I do not think the provisions are wise, but if they are to be enacted I do not believe that they should be enacted as part of this one bill.

I appreciate the opportunity which you have given me for expressing these views on a subject which I deem to be of great importance and in which I am very much interested. I know that you on this committee and others of your colleagues in the Senate and the House have given very earnest and constructive thought to this whole subject, and I have great hope that out of your work may come a type of governmental activity which I believe will have permanent value in the economy and security of our United States.

(Senator Kilgore took the chair.)

Senator MAGNUSON. Senator Smith, have you any questions?

Senator SMITH. I would like to ask Dr. Compton one or two rather broad questions. Do I gather from your report, Doctor, that you feel the Federal Government, in providing funds for scientific research, would distribute that among various educational institutions, I might say blindly, trusting the institutions to properly expend, or would you want to focus on specific projects?

Dr. COMPTON. Senator Smith, it seems to me that the program of aid to institutions, as provided under the Federal land-grant arrangement, does provide the one thing, and I think that is useful and I believe it should be continued; but I think this foundation should not do that.

This foundation, it seems to me, should do the pin-point bombing, that is, try to tackle the most important problems, try to aid the most promising young men and women that are interested in science that can be found any place in the country, and try to assist in the development of the most important fundamental discoveries that may have an application in national security.

I think this foundation should aim at selected objectives, both as projects and in personnel

Senator SMITH. One more question. We are now contemplating Federal financial aid for research. What effect do you feel that may have on the hitherto research foundations supported by private funds or private foundations, like the Rockefeller Foundation, or further

the industrial set-ups. Will industry be expecting the Federal Government to support their set-ups? Do you see no conflict between the sources of funds?

Dr. Compton. No, sir. I see no conflict. I think the relationships between those are rather interesting and important. Take first the effect on the foundations.

Foundations don't get as large income on their endowments as they used to. The larger foundations are using capital as well as income and I think we can see the time not too far ahead when they will be less important in the picture. That is one reason why I think it is important for the Federal Government to begin to get experience in this field.

Insofar as the foundations remain active, they have the privilege of selecting very specific objectives. I think the largest of the foundations is the Rockefeller Foundation, and, big as it is, I know that every 2 or 3 years it revises its program, because it feels the world is too big for it to handle. It tries to pick a specific objective. For instance, in the division of natural science, with which I am most closely acquainted, it has picked as its prime objective the field of biology, and anything outside of that scope must be an exceedingly particular, important case, to get any consideration.

What I am saying is that the foundations are not big enough and they are getting smaller.

As far as industry is concerned, industry has, with very rare exceptions, never supported fundamental scientific research. A good many of the large companies feel that they don't have a right to do that, because of their responsibility to the management, to their stockholders. I think, considering everything, they have been mostly generous and far-reaching, but that is a problem. Now, we are finding in universities that we can get problems from industry which industry is willing to pay for, but they are all problems of an applied type, in which the industry has an interest in developing knowledge along certain lines because it sees an application for that. In my own institution, for example, we have a division of industrial cooperation, which tries to assist industries, but our great danger and difficulty is that from industrial sources we could support 90 percent of the research that we are physically competent to handle, but it would be too much on the applied side. We wouldn't be able to carry on the scientific side and consequently we are turning away proposed contracts or grants in very many cases, because there is the danger of warping us on the applied side.

Now our country with its industrial laboratories and inventive genius is naturally very strong on the applied side, but where we need the help is getting at the fundamental facts of nature.

Senator Smith. That is what I wanted to bring out. It seems to me we are moving toward expecting industry to more and more take care of our applied science, whereas the institution of learning and research, like your own institution, MIT, we look to for the pure science, supported possibly by Government funds.

I recall, Dr. Compton, when you and I were in Princeton together we used to try to get wealthy individuals to make contributions to our Princeton Scientific Foundation. Do you educators feel we are approaching the time when that source of supply will dry up and will the Federal program tend to ward those people off? Is there a policy there we should think about?

Dr COMPTON. I think so. It seems to be a matter of arithmetic. I think, as our friend, Patrick Garvin, used to say, "Arithmetic is the mother of all knowledge." It is pretty hard to see how new Rockefeller and Carnegie Foundations can be established. There are still a few wealthy individuals that have not yet died and left their wills, but the number is not too great. [Laughter.]

Senator SMITH. And a good deal of that will go to the Federal Government. One more question and I am through. In your mind does this foundation for scientific research include anything but the strictly scientific? Would you take the social sciences and humanistics, etc., or should they be left outside the field of Federal support?

Dr. COMPTON. That is a problem I have worried about a good deal, I am not sure I can give a sensible answer. Theoretically, I think it would be fine to include the social sciences; practically, I don't know where you would stop, because everything is social science, really, everything that human beings are interested in.

One difficulty that I see in trying to combine the two in one foundation is the fact that methods are so different, I think if they were combined in one foundation it would probably be necessary to do what is in fact contemplated in the bill— that is, have two divisions, one which specialized on one, and one on the other. That is the way some of the big foundations operate.

Senator SMITH. I might say I just read a report that Dr. Dodd of Princeton had submitted on the subject. He rather thinks you can't bring the social and humanistic sciences into this picture. This is strictly on the scientific end of the page.

Dr. COMPTON. It would certainly be a lot easier to handle and I think it would be handled more effectively if they were not brought in, but I don't want to say the social sciences don't need help. They have some terrific problems, but I am not sure in my own mind whether this is the best way to help them or not.

Senator SMITH. Is there any advantage also in relating this to social sciences insofar as bringing in the implications on our society of scientific advance? We were discussing that last night in connection with the atomic bomb, the extent to which these things have a bearing, on international relations and on our relations at home between people. I would be terribly interested to see that developed.

Dr. COMPTON. I think there is a real advantage in bringing the two together. As far as this Foundation is concerned, the only thing that would be effective in bringing them together would be in connection with the planning of activities that would be related and it is possible that the social scientists might be able to point out certain directions in which work should be done, but I don't believe they could do it very wisely, because the trained social scientists is not an expert in the physical sciences and he might very likely submit something that couldn't be done effectively.

It seems to me that the impact of the social sciences comes in under a very much bigger umbrella than a foundation of this sort. Everything in public opinion and the press brings about that impact. I don't think the additional gain that would come here would be very great. Also, I am somewhat suspicious of any group trying to set out a program of discovery of the facts of nature, as far as the fundamental science is concerned, on the basis of an anticipated exploitation or intensification of one or another social objective.

So, as far as the fundamental research is concerned, I don't believe the presence of the social scientist would be helpful and it would be better to have more of the natural science on there. When it comes to any stimulation of applied research, things that might be of benefit to the community, then I think the social scientist could be useful. I haven't given you a clear-cut answer, because I don't have a clear-cut decision in my own mind.

The CHAIRMAN. Doctor, I am very much interested in this social science discussion you have been having. It raises a question in my mind. All too frequently social science and physical science don't fit one upon the other. One points to a solution that can only be solved by the other and vice versa. I remember that after World War I one of our big foundations made a study which was really a social scientific study as to what caused Germany's loss of the war and they hit upon the shortage of proteins. That immediately went to the physical sciences as to how to offset it and Germany solved it by using the physical sciences.

I wonder if the two-division theory, under one umbrella, because one might point to a job for the other and vice versa. What is your reaction to that?

Dr. COMPTON. I think there is a real thought. That I think is the one strong argument I can see for joining the two.

The CHAIRMAN. All too frequently we find something out of joint in the social make-up of the world which we must solve through physical science, through creating some source of supply.

Dr. COMPTON. There is always a tendency to bring in the atomic bomb; I would like to avoid it but I can't help but bring it in at this time, because if it had not been for military security reasons, it could have been advantageous to have had some of our statesmen and other social scientists wrestling with this problem quite a while before the bomb dropped. Now the time is too short for them to handle it.

If you take some peacetime thing, rather than this war thing, in which I think the security was absolutely necessary for military purposes, I think you would have an example along those lines.

The CHAIRMAN. However, in that you have the reverse of the other; here physical science gave us a social scientific problem to solve on an international scale. It is my thought that probably everything should be under one foundation but handled by separate divisions, each headed by its own group for the interchange of information and possible mutual solution of problems.

Dr. COMPTON. I think there would be a very strong argument for that, but I think when we come to this pin-point attack we discussed a little while ago, insofar as needs of the people are concerned, social scientists can help pick out those needs. For example, the Departments of Labor, Commerce, kinds of governmental and social groups that are studying the problems of people, I think could point out some problems that the natural scientist might miss and which ought to be handled.

The CHAIRMAN. You feel that the present system, such as the land-grant system, have given adequate assistance to the training of scientific personnel without additional help?

Dr. COMPTON. No, I don't think it has been adequate. I think it has been helpful.

The CHAIRMAN. You can't exactly train scientific personnel with pin-point work. You simply have to do a little saturation bombing there, don't you, with some grants, to enable the schools to carry the personnel; and the personnel, incidentally, to get to the schools?

Dr. COMPTON. That is right.

The CHAIRMAN. We have had a sad experience in my State in the procurement of science teachers for our high schools, and even for our colleges. It is getting to be a problem to get a really good science teacher. Frankly, industry has taken a great number of them; foundations have taken them; they frequently have more opportunity for research with a foundation than they have in the teaching profession; at least they feel they do. There is a need for trained teachers of science. It is from the high schools that we get the students for the colleges and universities and from them that we get our post-graduate men, who eventually develop our science. That is one reason why I am interested in the question of grants; not to say to a college, "We will give you a grant; develop a certain thing." But, "Here's a grant, develop scientists."

Dr. COMPTON. I would include, when I talk about pin-point objectives, promising young men as objectives, which I think perhaps we are talking about the same thing.

The CHAIRMAN. Yes; the same thing.

Dr. COMPTON. I would include that.

The CHAIRMAN. I am in hearty agreement with you on selectivity, that there is no use in going into a field in which there is thorough exploration going on by some foundation or university or something of that kind, except to aid them if they are short on funds, to carry the exploration on; but when we do find a field that is deficient, that is the proper time to spend some money, Doctor.

Dr. COMPTON. I think there are two things, to find the field that is deficient and also find the new field that has very great promise ahead, those two. They would both be what I would call pin-point objectives.

The CHAIRMAN. I am interested in this patent matter you were discussing. A bill is like a problem in your laboratory; it is a guinea pig we are working on. You have had a great deal of experience with contracts with industry, in which they give you a contract to work out a problem. Under what terms do they usually give that contract? Do they pay you so much for working it out and take the results of research, or does the scientist get the results of research?

Dr. COMPTON. It varies a great deal. The great majority of the cases are—let me talk about my own institution.

The CHAIRMAN. Yes; I am asking about your own institution.

Dr. COMPTON. There we have a printed document that states the patent policy, and in that it states that the work that we are glad to do for educational institutions is work in which the results can be freely published and in which any patents and results will be handled for the benefit of the public, and one of the things we specify is that there should be nonexclusive licensing of patents. We find a lot of cases that come up that are of a special type and require special handling. Perhaps the majority of cases can be handled just by that.

The company that supports the work gets a patent, but under the contract they agree to give nonexclusive license on reasonable terms

to other agencies, and we have in many cases a contract with them that states that our assignment of the patents to them is contingent on our being satisfied after, say, 5 or 10 years, which is written in, that they are actually handling the matter in the public interest; and if not, the patent reverts to us, and we license someone else. When I say "reverts to us" I don't mean MIT, because MIT as an institution does not handle the patent, but we operate usually through the Research Corp. of New York, which was chartered to do such things.

Sometimes a case comes up in which the patent seems to be fine, but it is quite evident that some years of expensive work are going to be necessary to develop a know-how before the things can be sold or any profit can be made, and if you simply go out and license there freely, nobody will take hold of it to develop it. Sometimes in those cases we stick to the principle of nonexclusive licensing, but we will agree that no other license shall be granted, say for 3 years or 5 years, to give that company some protection in putting in further expense in its own laboratories to try to develop the commercial know-how, or we may sometimes write in the contract the statement that out of the royalties which may be paid, by licensees, the original development expense shall first be retired by the company. There are a variety of cases of that sort, but what we try to do is handle each one in the way we think will bring the thing into use by the public at reasonable price, as quickly as possible.

The CHAIRMAN. But you do have a definite policy?

Dr. COMPTON. If you wish, I will be glad to send you a copy.

The CHAIRMAN. I would like it very much.

Dr. COMPTON. I will do it.

The CHAIRMAN. Getting back to the proposed foundation, my feeling is that the patents policy governing this should be written into the plan, because there is no question in the world but what the Government patent policy has been most chaotic, no matter what the wording is. It seems to me the public, and also beneficiaries of the patents, will benefit if in creating the foundation the patent policies of the foundation are clearly established, rather than to try to do it by later general laws governing all patents. My thought is only to touch on patent policy in establishing the foundation; to set the policy in regard to Government money, with no attempt to revise general patent laws at all. That is the reason the wording is the way it is in the "guinea pig" edition of the bill.

Dr. COMPTON. One of the difficulties I would see there, Senator Kilgore, is, if I remember correctly the wording of the bill, it means if any grant of funds from this foundation is used in developing a project, then all patents in that field that are given by the grantee have to be assigned to the Government.

What actually happens in almost every case is that a project comes up because somebody has already developed something and has a bright idea, and it looks awfully promising, and you want to give some help to push it; but, as I understand the wording in your bill, it would mean before the man could receive any help he would have to agree to turn over everything he does to the Government. I think the way the thing should be handled——

The CHAIRMAN. Now, how do you handle a similar situation?

Dr. COMPTON. Well, we have a patent committee of our staff that sits down and tries to determine the equities in the things. We will

say, "Well, this man had certain ideas when he came"; that is, before he took any money. Obviously you can't take those away from him; but of the things he develops while he is doing the job—we will say if company X puts in $10,000, and our own institution, or a grant from research corporation, or what not, puts in $15,000, and so forth, then we try to make an arrangement which gives to each group that contributes to the development of that thing some equity, and then we have the provision that in case there is a dispute which can't be reconciled internally we turn the matter over to the board of arbitration, whose decision is final and outside of our hands.

The CHAIRMAN. You remember, Doctor, the original draft of the patent provisions in the old S. 702, which was a predecessor of this; we almost had your system in that. In that we provided while the Government had a right to the patents, the director of the board constituted a patent committee, to settle with the research workers, and anybody putting funds or material into it, exactly what the equities were; although the Government would have an option to take the patent, they would have to give tremendous reimbursement, not only on the amount of money put in but the value put in, by whoever did the work.

I think that was similar to your system, with an appeal in that case, of course, to the Court of Claims.

Dr. COMPTON. I think a statement of that sort would be preferable to the statement I read in this present bill, and I think something along that line is the way in which the thing would operate, actually, under either S. 1297 or S. 1285, if that idea is incorporated.

Senator MAGNUSON. Doctor, let me ask you just a question along that line. Secretary of Commerce Wallace now has a patent commission which is studying our whole patent system for the purpose of revising and reexamining it, which many of us here think should be done. He testified that a patent provision placed in this bill would not in any way interfere with the conclusions that this commission may arrive at later on. Our purpose in having some patent feature in this bill—and I will ask you if you agree with this—is that we hope that in the meantime, before patent laws are revised and reexamined, that this will be a working thing. There must be some provision, don't you think, in the bill to protect not only the Government but to protect both sides in the case?

Dr. COMPTON. Absolutely.

Senator MAGNUSON. Someone before the patent laws are revised under the grants of this bill may run into something terrific, and you would have to have some protection for both sides.

Dr. COMPTON. I think there must be a patent clause; yes.

Senator MAGNUSON. Doctor, I want to ask you this: After all, the reason that scientific hearings are now not only fashionable but interesting is because of the atomic bomb.

The CHAIRMAN. May I amend that and say that we are all scared to death?

Senator MAGNUSON. Now, you went into Japan first. I understand you went there ahead of some of the troops, and I think it is very important that you tell us what you can tell us of what you found, because, after all, this may all center around that business of atomic energy.

Dr. COMPTON. I can do that very quickly.

Senator MAGNUSON. Don't be too quick. The only information we can get is from some of you who saw these things. What did Hiroshima look like? Picture it as far as you can.

Dr. COMPTON. I can tell that very quickly. I didn't see Hiroshima or Nagasaki. I made three attempts, but there was a succession of typhoons passing Japan at that time. Twice the plane couldn't get off, and the third time it was turned back.

The CHAIRMAN. Could those two explosions have had any atmospheric effect?

Dr. COMPTON. No. Those typhoons start way down somewhere around Singapore or Borneo and go on north. I am sure that could not have been, sir.

The Army had three committees in there to study the atomic bomb, under General Farrell, and later under General Newman. I talked with members of those committees, and I will give you in a moment the summary of what I learned from them.

Our mission was not the atomic bomb. Our mission was to find out the organization of Jap scientific work. Our first plan was to find the Van Bush of Japan and get all we could out of him and follow on the various scientific activities, see how far they had gone, order all their records and laboratories to be put under guard wherever we found anything significant, so they could later be examined at leisure by the military technical teams when they got in.

As to the Jap work on the atomic bomb, this is the story.

Senator MAGNUSON. This is what they were doing?

Dr. COMPTON. This is what they were doing. They had several very competent scientists; one, in particular, Dr. Nishina. There was a good deal of talk among their scientists about atomic energy and atomic bomb, and they sat down to make some calculations and came to a mistaken conclusion—their theoretical calculations led them to the conclusion that, although energy would be released, it wouldn't be released fast enough to be of explosive violence, so they did no work on atomic bombs.

They did start work to develop atomic energy as a substitute for coal, and in the laboratory of the Institute for Physical and Chemical Research in Tokyo they set up a laboratory apparatus to separate this uranimum 235 by a thermodiffusion method, which was one of the methods described in the report. That was not a production outfit. It was only a laboratory device out of which they could get the necessary information that could be used in beginning a production plant or a pilot plant, but before they got the things working or got any observations, our B–29 got over and burned the building and wrecked the apparatus, and that is all they did, and that is all we were able to find out about Jap progress in Japan.

Senator MAGNUSON. Did you find any evidence of liaison with German scientists?

Dr. COMPTON. No; we did not, but there is evidence that there was some information and equipment on the way when the war came to an end.

Senator MAGNUSON. From Germany?

Dr. COMPTON. From Germany; yes. Hiroshima and Nagasaki—others can tell better than I can, but I talked with the American groups and Japanese groups who investigated those sites, particularly

this Dr. Nishina, who was down in Hiroshima 24 hours after the bomb went off, and 24 hours after that he had his radio measurements under way. The Jap scientists and our scientists got in as soon as they could and agreed entirely on all their scientific findings. That was not true of the statements that came from the Jap press, but our scientists and the Jap scientists agreed.

One of the points on which they agreed is there was no evidence that anybody was injured in that area except people in the area when the bomb exploded. This talk about long poisoning of the ground afterward was all wrong. There is no evidence at all.

Senator MAGNUSON. We want all the information you can give us, because the American public wants to know.

Dr. COMPTON. Well, in Hiroshima, a radius of about 2 kilometers from where the bomb went off was completely destroyed. They told us, when we thought we were going to get there, that there was no point in going, because there was nothing to see; and I said, "What about the odor of dead corpses?" I had recently been through Corregidor, where the odor is pretty terrible still. They said, "Corpses? There are no corpses. There is nothing. Within a radius of 2 kilometers, there is nothing."

Senator MAGNUSON. What is a kilometer?

Dr. COMPTON. Two kilometers would be a little over a mile. Then, for another mile-and-a-half radius there, the destruction is about what it would have been from a good saturated bomb area, and then——

Senator MAGNUSON. About a 3-mile——

Dr. COMPTON. A 3-mile radius. Beyond that 3-mile radius, there is spotty destruction, where apparently there must have been focusing effects, where echoes from this blast from two different sources would meet, or something of that sort, and up to as much as 10 miles there was some damage, but spotty. It was complete within 3 miles.

Senator MAGNUSON. Did you find the evidence of the effect of the glare on people outside?

Dr. COMPTON. I heard no comments on that; I can't answer that. One thing we did hear some interesting stories about was the effect of the radiations from the bomb, which would include neutrons and gamma rays, which are like X-rays and heat and light and everything else. Our scientists had estimated that the lethal effect of the concussion from the blast would be effective at a greater distance than the lethal effect from these radiations; and, consequently, they had not considered these lethal radiations as playing a part in the number of people killed, because if they were killed by those, they would have been killed by the blast effect anyway. But perhaps because of sound reflection or interference effects, there were small areas within that 3 miles, where you would have expected the blast effect to have been fatal, but where people were not killed by the blast effect, and within that distance some of them were killed by these radiations.

There was one interesting case. I think it was nine guardsmen, who were at the military headquarters, sitting on a bench with their backs against the wall, and it was well within the region where the blast should have killed anybody; but for some reason none of them were killed. But people all around them were killed. The following day one of those men died from one of these radioactive radiations.

Two or three days later, a couple more of them died. Up to the time I left, all but one had died, and that one man showed no evidence of any injury whatsoever. His blood count was completely normal as far as the medicos could find out. He had not been damaged at all. There was a freak. I don't think it is very important; it is a matter of interest. Down at Nagasaki the situation was different. As you know, there the pilot only got a 30-second glimpse of the city. He didn't have time to place his bomb. He saw there was something to hit, so he let go. The city of Nagasaki has a center, and there are a lot of ravines that run between the steep hills, and the bomb dropped through the mouth of one of those ravines, and the hills protected the surrounding country, so the area was not so great. The bomb dropped about one-third of the distance, on a line between an ordnance factory and a steel plant, about one-third the distance from one, and two-thirds the distance from the other. They told me it was something worth seeing, because there you could see the twisted steel of those two plants. They were something like a mile apart. But I personally didn't see them.

The CHAIRMAN. They were destroyed?

Dr. COMPTON. Completely wrecked, and the steelwork twisted.

Senator MAGNUSON. From what you heard, coming to some scientific conclusion of the effects of this bomb, what would happen if it were dropped on one of our American cities—for instance, a city that would be concentrated insofar as buildings were concerned?

Dr. COMPTON. The effect would be very terrific; there is no question about that. It would destroy everything within a radius; just exactly what the radius is, I don't know.

Senator MAGNUSON: Everything in the radius would be gone?

Dr. COMPTON. Yes. There is another thing I think you might be interested in, in connection with the military and the national security aspect of this bill. I referred very briefly to the fact that in Japan the most striking thing we found was the lack of teamwork between the various groups, between the army and navy. One of their most prominent scientists replied to our question as to how the army and navy cooperated with each other with these words—he said that an admiral and a general would lose the war before they would shake hands with each other, and we asked an army officer——

Senator MAGNUSON. I will have you testify in another committee discussing the matter.

The CHAIRMAN. I think we will note him for attendance [Laughter.]

Dr. COMPTON. We asked an army officer the same question about the cooperation between army and navy, and it was like that. The Japanese civilian scientists were apparently greatly distrusted by both the army and navy, and we didn't find a single case of a university scientist who had been asked to do some war job who was given the information as to what that war job was to be—what was to be the military use. It was like this: Suppose they set out to design a radio set. To a professor in one university they would give the job of designing a radio detector tube; and to a scientist in another university, the job of designing a radio amplifier tube; and to the Tokyo Shibaradanki, which is the general electric company in Japan, the job of designing a condenser. They would give them certain specificatons, but none of those men would have known the objective was to

build a radio set. Each man knew only his own job; he didn't know the other things that had to go with it.

Senator MAGNUSON. Things not necessarily secret.

Dr. COMPTON. The result was, when they put those things together and tried to make a radio set, it didn't work, because there was no system in engineering. The reasons for failure to trust the civilian scientists were several. One was that most of the Japanese top scientists have been trained in Europe or America and had been for 4 to 7 years in residence, with frequent visits, and they were suspected by the Japanese military of having foreign connections or foreign sympathies, and that is one reason they were not trusted. Another reason is that the technical people in the military establishments were not as competent as these university scientists, and to save face, and not be shown up, they didn't want to get into any discussion, so they would give certain orders for things to be done but not take the groups into confidence. Even the job industries, the electrical companies that built Japanese radar sets, for example, were never permitted to see the field tests in the proving ground or get the reports of those field tests. All they could get in return was orders to do this or that and change the set.

I think that is just exactly the kind of thing we want to avoid in this country. We want to do just the opposite.

The CHAIRMAN. The reason that is interesting is that the scientists in the military group were blocked.

Dr. COMPTON. Mostly officers.

The CHAIRMAN. Did you find this, which we asserted 2½ years ago prevailed before the fall of France, that the military forces in France would not accept information or advice from the scientific personnel of their universities or their leading scientists in solving problems?

Dr. COMPTON. I think our investigating attempts that have been made in Germany since VE-day, and even before, have verified the fact also that in Germany the cooperation was not nearly so good. I think we can be pretty proud in this country of the way we have handled that.

Senator MAGNUSON. The cooperation, you speak of.

The CHAIRMAN. Do you think you could have done better scientific work if you had been a general in the Army than you did as a civilian? I am just talking about that in reference to whether it would have been an advantage. Or do you think being a civilian was an advantage?

Dr. COMPTON. It was an advantage to be a civilian. In the Philippines I had the best deal; I was a major general in the Army, and on the outside I was a civilian.

The CHAIRMAN. I wanted to ask two other questions. There was a lot of newspaper gossip about the death ray they had over there. Did you hear anything about that?

Dr. COMPTON. Yes; I can tell you quite a story about the death ray. This was, in the first place, before we went to Japan, while we were waiting in Manila. We were studying reports that the Counter-intelligence Section of the Army had gotten, and translations, and they told about this death ray. I can almost quote it. One of them is of interest to people in Washington. Dr. Yagi, who was up until last May the Vannevar Bush of Japan, made this statement, or published it. He said:

I have a dream of things to come. I am on a mountain, and I seem to see an opening into a deep cavern, out of which goes luminous rays up into the sky.

I follow it more closely across the ocean, and it terminates in Washington, the Capital City of our enemies. By presssing a button, Washington completely disappears. I go closer, look into the cavern, and see a mass of iron—it looks like iron; it might be a cyclotron; but no—it is greater than a cyclotron. My vision ends.

That was published and fed the Japs. Well, we talked to Professor Yagi, and this is what we found: Some years ago, in talking to Dr. Coolidge at our General Electric Co., Dr. Yagi had suggested that it might be possible to stop the action of an internal-combustion engine by focusing an intense beam of an electro-magnetic wave, which would cause sparking and interrupt the operation of the spark plugs. When he got back to Japan and he tried it, he said he could make it work on a Ford car if the hood was up, but if the hood was down, unfortunately the metal shielding prevented its working.

The CHAIRMAN. At what range did he say he could make it work?

Dr. COMPTON. Oh, 30 or 40 yards. That, however, suggested another experiment, as to whether, by focusing these intense electro-magnetic rays, you could produce a lethal effect on a living object; and using a very short wave, 80-centimeter wave-length rays, from a high-frequency radio oscillator, and focused by a parabolic search-light, he could kill a rabbit at a distance of 30 yards, just like that. But he said muskrats were much more resistant.

We asked him whether he ever made any experiments on human beings, and he shook his head vigorously. He did say that in a province a hundred and fifty miles from Tokyo they were conducting these experiments with greater power. He said they are still using 80-centimeter radio waves but had an oscillator that would deliver 200 kilowatts of continuous power output, at which our people pricked up our ears, because that is considerably better than we have been able to do, and he was using a mirror, a reflector, to focus this thing, that was about 30 feet in diameter. That is a little hasty calculation, which I have not verified, but I am sure it is an order of magnitude.

One of the group with us figured that on the basis of their early experiment, that could kill a rabbit at a distance of about three-quarters of a mile. We figured it would be much easier to kill a rabbit with a rifle at that distance. Then we interrogated the electric company that had produced this oscillator, and they pooh-poohed the idea of 200 kilowatts output. They said their order had been to produce one for 40 kilowatts output, which seems somewhat reasonable, but they had never been able to meet the specifications. I think that is the story. I think it is just absurd. I think it was like a lot of other things in Japan. These paper balloons, for example, they had a production order on them for 8,000, of which 2,000 had been delivered and sent, and the purpose of the thing was for internal psychological effect on their own people. They were getting bombed, and they wanted these people to see these bombs going up to bomb the enemy.

The CHAIRMAN. What kind of paper did they use?

Dr. COMPTON. I didn't see it.

The CHAIRMAN. It was supposed to be a very fine grade of paper.

Dr. COMPTON. It probably would be, because the Japs could make excellent paper. We got the record, but we didn't actually see it.

The CHAIRMAN. Would it be possible actually to deliver, shall we say, an atomic bomb in the United States by balloon?

Dr. COMPTON. It would.

The CHAIRMAN. Yes?

Dr. COMPTON. That is, if you make the bomb light enough.

The CHAIRMAN. Or the balloon big enough?

Dr. COMPTON. Or the balloon big enough. You would have to have a balloon with a lifting capacity of about a ton.

The CHAIRMAN. Now, you would have to send a pilot to guide the drop, or it might explode any place. They had no way of making a balloon drop over a city rather than over open land, did they?

Dr. COMPTON. No.

Senator SMITH. Do you have reason to believe you were able to get all the scientific information they had? Is it possible any secrets were kept back from you?

Dr. COMPTON. On the whole, I think we got the information very freely, surprisingly so. We had a number of opportunities to check; for example, we had the information that had been received from Germany as to what assistance had been given to Japan, in what fields, and about what time, and they didn't know we had that, but at least we could check them on that. We could countercheck then in various ways. I think perhaps because of their feeling of inferiority, their scientific and technical groups, who, after all, are very much bound up in their professional fields, seemed eager to show us anything they were doing that they thought might get a little commendation. I think their inferiority complex drove them to show us what they are doing.

Senator SMITH. Mightn't that indicate that that group might be good material to work on, to bring them to our American point of view?

Dr. COMPTON. I think they are the most helpful group to work on.

(Off the record.)

Senator MAGNUSON. Doctor, I wanted to ask you a question, as there has been a great deal of probably loose talk, or maybe sometimes even wild tales regarding death rays and things of that type, of scientific development. I think you could do us a great deal of good here by making a statement regarding the possibility of the use of atomic energy in our economic fields. For instance, in my section there have been stories circulated, and in the press, that possibly the use of atomic energy may make obsolete our great dams in the Columbia River, our huge sources of electric power. I am just wondering whether or not you think atomic energy could supplement the electric power resources, or whether it will fit into our economy gradually. I would like a statement along those lines, because you are one of the people who know. We don't know, and the American people don't know.

Dr. COMPTON. There are other people who have been a lot closer to this than I have, and there are two of them here, on each side of me. But I think it is safe to say that the development in the first place will come slowly, and I expect the first development will be for some rather limited objectives, and it will grow from there.

I don't think the development will come any too fast, to be useful, as some of our other sources of energy, like oil. I don't think you will find serious competition.

Senator MAGNUSON. What about hydroelectric power, which is permanent?

Dr. COMPTON. Yes, that is permanent. Once you have the installation, it is cheaper than anything else you can imagine. I don't see how it can be displaced once we have it.

Senator MAGNUSON. Senator Kilgore's statement being, probably the whole economy is based on coal.

The CHAIRMAN. Not the whole, but a major portion of our economy is based on coal.

Dr. COMPTON. Certainly within anything now in sight the cost of production of atomic power is quite high in comparison. How low it might be gotten with future discoveries, I don't know, but the present cost is very high, so in industrial use it might be for limited objectives. For example, this might affect your coal a little bit, I don't know. One obvious large requirement for power is in ship propulsion, and there you have an economic factor that would work in favor of atomic power, because if you could use your coal or oil bunker space for economic cargo, then you have an additional economic factor that you won't have in a thing like a stationary engine. Whether that can be done or not, and how soon, I don't know.

The CHAIRMAN. During the depression the British tramp freighter, a famous ship on the seas, found it economical to cut down hold space and come into Norfolk and load part of the hold full of coal and use that coal in the outward voyage going to England, by way of Singapore. Using oil, which was much more compact, they found that they could save still more hold space, and they were operating when we couldn't operate our own bunker ships.

Dr. COMPTON. Far be it from me to throw any scare in the coal industry, because I don't think we are near that point.

The CHAIRMAN. If we go in strong on things of that kind, might we disturb the earth's mass by extracting or using too much?

Dr. COMPTON. Well, I wouldn't anticipate any trouble there. It seems to me that this matter of atomic energy, as far as commercial use is concerned, makes us feel a little the way Noah felt when the dove came carrying a branch. He knew there was land somewhere, but he didn't know what was there. I think we want to find out.

Senator MAGNUSON. You wouldn't sell our coal or iron or hydroelectric stock at this minute?

Dr. COMPTON. No, they might be needed to produce atomic energy. [Laughter.]

Senator MAGNUSON. I just have about three questions here, and then we will let the others go on. I am sorry to take so much time, but this has been very interesting to us.

In the committee print there is an international clause which provides that the Government should participate insofar as possible in this foundation officially in international scientific congresses, and I presume you people favor that inclusion.

Dr. COMPTON. I favor it very much. It has been a thing in which we have been very sadly deficient for many years.

The CHAIRMAN. I want to ask one question on that. Don't you think at those congresses our representation should be official national representation, and not just volunteer representation? There may be as many volunteers as want to go, but we must have and should have an official delegate there.

Dr. COMPTON. Yes, I think that is true.

Senator MAGNUSON. In your prepared statement, you expressed the fear that possibly, unless we have a free development in basic science, under these scholarships and other grants-in-aid the military may come along and say, "This is a secret; you can't do anything with this," which would hamper that. In the committee print we also have a Division of National Defense, in which they set up Army and Navy men, and scientists in the various departments. Do you think such a division within the foundation would be desirable, or would hamper this freedom of scientific research of which you speak?

Dr. COMPTON. I think it should be set up the way it is here in the bill. I think it is all right within the foundation, because I think we all understand, maybe not all agree exactly, where the boundary line should be drawn. But the principle I think is clear. I take it this Division for National Security would not support fundamental research in the sense we have been talking about, fundamental research, it would be applied research, aimed at specific military objectives, perhaps pretty forward-looking. It might be aiming at things that are still too speculative to be the jobs of the various arsenals and research "labs," but still with different objectives in view.

Senator MAGNUSON. Both the Secretary of War and the Secretary of Agriculture have testified that this wouldn't interfere. Wouldn't the foundation in itself be an assurance, a buffer, say, against the military coming in and saying, in other words, they would have to prove their point before the military could interfere.

Dr. COMPTON. Yes.

The CHAIRMAN. Isn't it a fact that the basic research upon which the atomic bomb rests was fairly general knowledge among scientists? The actual putting them together was accomplished here, but all the fundamentals, the fundamental theories were in existence long before, and were somewhat general knowledge among the leading scientists of the world, so the getting of fundamental research doesn't need to remain a military secret?

Dr. COMPTON. I would like to put it in this way: There ought not be any secret about what we call a fact of nature. When it comes to the way to apply those facts of nature, I think there are some categories in which we ought to keep things secret or confidential, unless some satisfactory arrangements can be made.

The CHAIRMAN. Yes. Thank you very much, Doctor.

Senator MAGNUSON. Thank you, Doctor. We appreciate your coming.

(Additional material submitted by Dr. Compton:)

NOVEMBER 16, 1945.

Senator WARREN G. MAGNUSON,
Chairman, Subcommittee Considering S. 1285,
Washington, D. C.

DEAR SENATOR MAGNUSON: I enclose copy of the hearings on science legislation with two minor corrections as indicated on the cover.

I am also reminded that I promised to send you a copy of our M. I. T. pamphlet, Policies and Procedures, which describes our method for handling patents at M. I. T. This pamphlet is also included herewith.

The pamphlet does not go into detail with respect to the principles according to which patents are handled. I described these principles to some extent in my testimony. Let me recapitulate as follows:

Our basic principle is to handle each case in a manner which appears most likely to bring maximum public benefit. We avoid exclusive licenses and we insist on such handling as will make the product available to the public at as low cost as may be justified. One element in this latter point is to charge rather

nominal royalties and to see to it that any income from royalties, after defraying the expenses incident to the patented procedures, is used for educational or further research purposes. Originally we provided that no individual, not even the inventor, would receive any income from a patent handled by M. I. T.—the reward to the inventor coming through the fact that his accomplishment would be treated by us just like good performance in teaching or good achievement in fundamental research; that is, it would be recognized in the usual academic manner through salary increase and promotion. Subsequently on legal advice we did introduce a nominal participation by the inventor in any income in order to avoid possible charges by his heir or the administrator of his estate that he had been unfairly defrauded or compelled to forego income to which he was properly entitled.

The actual patent situations are so varied in nature that it is impossible to achieve these fundamental objectives by any simple formula. This is the reason for handling each case on its merits, where the principles are consistent but the procedures to achieve these principles are adjusted to fit the case. I could give many examples. In perhaps half the cases, everything is very straightforward and we assign the patent to Research Corp. or some similar agency which proceeds with the prosecution and assures nonexclusive licenses. In some cases it is very evident that a large amount of developmental work would have to be done before the product could be manufactured and sold, and M. I. T. is not a proper place to do this type of development work. In such cases no company would undergo the expense of this development unless it had some way of recouping this expense in order to be at least on an equal basis with any other later manufacturer. In such cases we might, for example, agree that no other company will be licensed within a period of 3 years, after which licensing is open to any qualified manufacturer, thus giving the developing company an advantage in time to compensate for its initial expenditure. Or in other cases we may stipulate that the company which puts in the development money may sell the product without payment of any royalties until the amount of royalties which it would otherwise have paid has been equal to the money which the company invested in the development, after which it pays the same royalties as anyone else.

Another type of situation is where a large group of companies—like those which have established the Sugar Foundation, for example—finance at our institution a large program of fundamental scientific research. In such cases we may agree that any patent coming out of this research will be licensed only to the companies which have combined to finance the work up to a period of, say, 10 years, after which the patents would be thrown open to any or all qualified manufacturers.

A very common case is one in which there is already an existing patent structure, or at least an existing background of research and development which is, in fact, the reason why a company or a Government agency comes to us to continue the work. In that case it would be unfair and impracticable to have the inventor or the institution agree to turn over everything in that field which may have been done earlier or during or subsequent to the financial support given us. In such a case we work out a plan which represents the equities as best we can. It usually takes some such form as an agreement to turn over to the governmental or other contracting agency such patent rights as develop out of the work wholly supported here by that agency and to assure the agency that it may have license rights as favorable as those given anyone else under the preceding and subsequent developments in the art.

Unless it is possible to handle individual situations on the basis of the principle of public benefit rather on a definite rule of procedure, it will be impossible to accept contracts or other financial assistance in a large portion of interesting cases. It is for this fact that I feel that the present patent provision in the Kilgore bill (which sounds perfectly sensible and proper to one who has not had experience in these matters) would very seriously defeat the basic purpose of the bill, which is to stimulate scientific work in the interest of the public.

If the patent question is not mentioned at all in the bill, then it would clearly be the duty of the foundation and its director to work out policies for handling patents in the interest of the public. These policies might take somewhat the form of those which we have developed at M. I. T. or of those which have been followed by OSRD, or it might well be that these policies could be further improved. I feel that the foundation should have freedom to develop its policies, on the basis of past and continuing experience, so as to meet most effectively the main objective of the bill, which is to promote science in the public benefit.

If a statement regarding patents should be included in your bill, I should hope that it would take some such general form as an instruction to the foundation to handle patents in a manner best calculated to bring maximum benefit to the

public. This would define the objective and would leave to the foundation the freedom to meet this objective by the most just and skillful methods which it can devise.

I feel that this point is really a critical one, and wish that I might have emphasized it more cogently in my testimony. Would it be possible to have this letter introduced into the testimony as a supplement?

Very sincerely yours,

KARL T. COMPTON, *President*

(Senator Kilgore assumed the chair.)

The CHAIRMAN. We will now hear Dr. Smyth. Will you qualify yourself, Doctor?

TESTIMONY OF DR. HENRY DeW. SMYTH, CHAIRMAN OF THE DEPARTMENT OF PHYSICS, PRINCETON UNIVERSITY; AUTHOR OF THE WAR DEPARTMENT REPORT ON THE ATOMIC BOMB

Dr. SMYTH. I am Dr. Henry Smyth, chairman of the Department of Physics at Princeton University; I have been associated with the atomic bomb work, in one way or another, for about 5 years and, as a result of the peculiar designing of circumstances, was selected to write the report which the War Department issued on the atomic bomb. I have had some connection with OSRD—I think I should interpolate here that I have not seen Dr. Compton for some months until this morning, so what I say is not taken from him, or prepared in collusion, although you will find in many cases it is almost identical.

There are several reasons for advocating large-scale support of scientific research by the Federal Government. First, the important contributions to the war by science have emphasized its great significance to the country both in war and in peace. Second, many aspects of fundamental research in nuclear physics and other sciences today require far more expensive equipment than has ever before been necessary. Third, the general financial problems of most universities and other non-profit-making institutions are now too great for them to continue research on their previous scale or to expand without Federal aid.

The objectives of Federal aid for research must be in the narrow sense to build up a backlog of scientific knowledge and scientific men in case we should have to fight another war. In the larger sense, the objective must be the promotion of all human welfare through the stimulation of creative ideas, the development of new industry with increasing employment and a higher standard of living in this and in other countries.

These objectives can best be attained through establishment of a national foundation financed by the Congress but administered by men whose first allegiance is not to the Army, the Navy, or to any political group but to the disinterested advancement of knowledge through science. In my opinion, the first principle for the success of such a national-science foundation should be that its governing body be composed not entirely but preponderantly of scientists of established reputation and that its executive officers be men well acquainted with the methods and needs of real scientific research. If this principle underlies establishment of the foundation, its possibilities for success will be great and its support by the people of this country will, I think, be very strong.

There is a second principle which I believe essential to the success of any such national program for scientific research; that is, the clear realization by the foundation itself and also by the Congress and the people of the great difference in methods and values between fundamental science and applied science. We have heard again and again recently that the war has proved the advantages of organized and directed scientific research. This statement fails entirely to distinguish between pure or fundamental science and applied science. There have been no great advances in fundamental science during the war. On the contrary, the last 5 years have been a period of almost complete stagnation in fundamental science, and this means that the fountainhead of all our future scientific developments has run dry. The progress in applied science during the war had been remarkable, but we have merely put to use the knowledge of nature's laws acquired before 1940. For applied science organization is helpful though it can be overdone. Usually there is a definite objective which can best be realized by a group working cooperatively and under direction.

For fundamental science the only objective is greater knowledge of the laws of nature. Here the best results, I might almost say the only results, are obtained with a minimum of direction and organization. Here what is needed are men of keen imagination working with adequate facilities and bothered as little as possible by reports, reviewing committees, and the like. Personally I believe that the great research foundations that contributed so largely to science in this country between 1920 and 1940 would have accomplished even more if they had not overemphasized particular projects and immediate objectives. New ideas and the men capable of having such ideas are what count.

Might I interpolate there a comment on some of Dr. Compton's statements. You will note he cited the National Research Fellows as a great contribution to science in this country in the period since the last war. That is exactly what I mean here. That is the kind of thing that is important; new ideas and the men capable of having such ideas are what count.

The greatest discoveries in nuclear physics between 1920 and 1940, the discoveries on which the atomic bomb is based, came more from Europe than from this country. This is a point that thoughtful Americans should ponder. The reasons for it are complex, but at least it shows that money and equipment do not automatically produce great discoveries. Like the atomic bomb, Federal aid for science has great potentialities for good and for evil. In the field of fundamental science there must be a minimum of organization and direction with little expectation of immediate results. I would almost say that if the first 5 years of Federal aid to the scientific departments of universities and other similar institutions show such tangible results as new guns, better radios, or new gadgets for the kitchen then the money will have been unwisely spent. But if after 5 years we know more about cosmic rays and sources of energy in the stars and other such fundamental know-how, and if we see a large group of well-trained young scientists capable of investigating such problems and eager to do so, then the money will have been well spent.

The CHAIRMAN. Do you think it is advantageous in fundamental science to have some medium for the free transmission of information among the men who are working?

Dr. SMYTH. Yes.

The CHAIRMAN. For instance, a man, in Princeton's laboratories might be working on a fundamental theory, and a man in California, and possibly a slight exchange of ideas would help both of them in obtaining their ultimate objective, some medium so that one would find out what the other is doing, so that eventually they would get together and talk things over. As it frequently happens, particularly in the case of a younger scientist, he is going ahead working, and somebody else is doing the same thing, and maybe each has a solution to the other's problem that is stumping him at that time.

Dr. SMYTH. I think the exchange of such information is essential. It isn't always harmful to have two people do about the same thing.

The CHAIRMAN. Oh, no; but each could help the other if he had that information.

Dr. SMYTH. I should say that has been emphasized during the war, where even within a project one group didn't know what the other was doing. I am sure it has caused very serious delays. Does that answer your question?

The CHAIRMAN. Yes.

Dr. SMYTH. Applications of these new fundamental discoveries will come later as has been proved time and again. In this country we are old hands at applied science. I have no fear that we will lag behind in that field. In fundamental science, however, we have always depended very heavily on Europe. Now we must lead in this field also, but to do that we must understand clearly the conditions under which creative thought is free to develop.

If we are to take a leading position in fundamental as well as in applied science, we must have able men. Because of the Selective Service policy, we are now suffering from a great scarcity of trained scientists, a scarcity which will persist for some years. This leads to the third principle which I believe necessary for the success of a Federal research program. Grants of scholarships to promising students must be made on a wide scale.

Might I interpolate a comment there arising out of something Dr. Compton said. Although we might want to limit direct scholarships to the natural sciences, I think that they should be given on a broad basis. I would rather pick a high-school boy who showed signs of being really very intelligent, even if he had done little in science, than pick a high-school boy who had spent a lot of time building radios at home, but showed no interest in general education.

The fourth and last principle I hold to be essential in Federal aid to research is the atmosphere of freedom, which has always been the basis of progress in this Republic above all among men of science. It will be difficult to allocate funds for national scholarships or for research without reference to momentarily dominant political or economic groups or philosophies. But this must be done. We cannot tell our scientists what they should think.

The CHAIRMAN. Might I ask if you have any information on how Russia selects their young students to go to schools of advanced education for scientific studies? I know they are doing a tremendous lot of that, and I am wondering what system of choosing they have.

Dr. SMYTH. I haven't any idea at all.

The CHAIRMAN. Dr. Compton, do you have any idea?

Dr. COMPTON. I think I know what they were doing 10 years ago, and that was, at each stage in schooling, which would correspond to

our passage from the grammar school to high school to college, the teachers went into a huddle and decided such and such pupils would be good for this, and such and such for that, and they were directed for their further education into the channels their teachers or such had.

The CHAIRMAN. Dr. Urey, have you had any experience with that?

Dr. UREY. I know nothing about it at all.

Dr. SMITH. We cannot exert Federal pressure over the institutions where they are now free to think. I believe the people of this country understand this principle and will support a policy of freedom in Federal aid to research if such a policy is implicit in the structure of the national foundation and in its actual management.

The CHAIRMAN. Let me ask you this: There is included in S. 1297 a provision to make sure that there is no restriction on the interchange of information, because such a fear has been expressed by some. Now, some of the witnesses thought that provision was pretty drastic. Do you think it would be better to have such a provision to require the Director to protect the scientist from being bludgeoned into keeping his mouth shut—in other words, to make him a protector of the freedom of speech among scientists.

Dr. SMYTH. I don't know how this thing should best be applied. I don't see what harm such a specific directive can do, and I think it might do a good deal of good. It does very clearly state what the principle is, so that I think I like it.

The CHAIRMAN. It was put in because we have had complaints. We were trying to prevent the possibility of a complaint of that nature. Go ahead, please.

Dr. SMYTH. The foundation should certainly be responsible to the President and the Congress, but at the same time it cannot possibly operate for the benefit of this country unless it grants complete freedom of thought and expression to the individuals and institutions to which it allocates funds.

Finally, I cannot talk sensibly about the future of science in this country without explaining my belief in the profound interrelation of the biological, medical, and physical sciences. Progress in each of them now depends upon progress in all of them.

It is quite impossible to maintain secrecy in one field of science without gravely weakening the others. It is highly probable that the study of cosmic rays may lead to the atomic bomb of the future. The byproducts of atomic bomb manufacture are certain to be invaluable in medical and biological research, and so on. I firmly believe that if this country is to maintain a strong scientific and military position over the years there must be free interchange of information about fundamental science, and this includes nuclear science. Although I sincerely hope we shall be patient enough and wise enough to avoid future wars, I emphasize the military position because it offers the only possible excuse for secrecy. I am not here recommending that we publish the technical details of the manufacture of atomic explosives or tell how the atomic bomb is finally put together. This is the only "secret" of the atomic bomb that we should keep to ourselves for the moment. There is a large amount of scientific material gathered by the scientists working on the atomic bomb project and other war projects that is of relatively little technological interest to anyone trying to manufacture a bomb but is of importance to fundamental scientific research. Immediate publication of these data I consider

essential for our progress in all fields in this country, industrial as well as scientific. I have said all sciences today are interdependent. Secrecy in nuclear physics will smother the hope of progress not only in that science but in all the other sciences, both fundamental and applied. In my opinion continued secrecy means national scientific suicide. It also means international scientific isolation, which is equally fatal to our progress and to our human relationships with the other nations through whom and with whom we must hope to build a world government.

Now I would like to make a few very amateurish comments on the proposed bills. I shall confine my comments on proposed legislation to three bills: S. 1285, in what I take to be its original form, dated July 19, 1945, proposed by Mr. Magnuson, S. 1285, with the revisions shown in the committee print of October 12, and S. 1297, as shown in the committee print of October 8, which I take to be the present form of Mr. Kilgore's bill.

First, with respect to the original form of S. 1285, Mr. Magnuson's bill, within the limits of my understanding of legislation, this seems to me excellent. The powers and duties of the foundation as related in section 2 cover the objectives which I believe need to be covered in a general and intelligent way. The authority for carrying out these duties is vested in a board which could and, I hope, would be nonpartisan and would contain a reasonable proportion of scientific men. My only suggestion here would be that the presence of scientists on the board should be explicitly required. I have a minor suggestion to the effect that the members of the board receive compensation of, say $50 per diem, for the time that they actually give to this work. I think that this might make them take their duties even more seriously. I like having the director of the foundation responsible to the board. I think the five divisions proposed cover the field adequately and I like the proposal for committees within a division. The provision that the committee for the division of national defense include representatives of the War and Navy Departments seems a sufficient assurance that the interest of the services will be safeguarded. The provision on page 8, lines 19–24 that funds once appropriated remain available for 4 years is an essential one if emphasis is to be put on long range fundamental work rather than immediate problems. It is rarely possible to do a significant piece of scientific work in less than several years.

Turning to S. 1297, Mr. Kilgore's bill, perhaps I should say the objectives are not quite as clearly my objectives. I find the board of the proposed foundation merely advisory, the full power resting in the director. I find the constitution of the board overweighted with Government officials and do not like the constitution of the divisional advisory committees for the same reason.

I do like the provision that expert scientific consultants be employed without regard to civil-service laws. I do not like the provision of lines 14 to 19 on page 6 saying, "no officer or employee of the foundation, and so forth, shall participate in any decision * * * affecting * * * the activities in any organization * * * by which he is employed." A restriction like this has caused us great embarrassment in some of our war activities and I believe it entirely unnecessary in regard to nonprofit organizations like universities.

The CHAIRMAN. Can you expand on that and explain the background?

Dr. SMYTH. Yes; what I mean is this, specifically: Take our experience in the war. It was necessary to set up a committee which was going to pick the best place to do work in certain fields, to do research in certain fields. Naturally, one wanted on that committee the people who knew most about those fields. They were very likely to come from institutions whose research groups were particularly versed in that particular field. Therefore, they were in the position, perhaps, of assigning, or recommending, or making recommendations about contracts to go to their own institutions by which they were employed. There was no question of personal financial gain involved. But I think this provision tends to make it difficult to use the best men for the job.

The CHAIRMAN. Might I ask you a question on that, Doctor? How much money did you have to spend on research during the war?

Dr. SMYTH. I can't give you the figure. I know it is astronomical.

The CHAIRMAN. Yes; it is. We will look at this from a peacetime viewpoint. We were talking about the make-up of committees. That is the one thing that worries me. I believe that all human beings, whether they are scientists, or lawyers, or anything else, have their own pet feelings, their own pet beliefs, things of that kind; and I sometimes think the bigger cross section you get, the better off you are.

Do you feel the solution is a big cross section on this board, so that the effect of one man would not be so great, or to have a smaller board, and exclude any man from voting on anything which pertains to the organization with which he is connected, as we have had to do in Government? Government, unlike business and a lot of other things, is a system of checks and balances. You say you would put the top-flight scientists on that board. Your suggestion was that they must be men recognized nationally. If you were in the position of the President of the United States, going to pick that board, where would you get the man of top-flight caliber?

Dr. SMYTH. You would get them largely from the universities, from some of the research institutes, and some from industry certainly.

The CHAIRMAN. In what type of university would you usually find a nationally known scientist?

Dr. SMYTH. Well, they are pretty well distributed among the State and private universities, I should say, if that is what you mean by type of university.

The CHAIRMAN. You don't hear of so many of them coming from the smaller universities, do you?

Dr. SMYTH. No.

The CHAIRMAN. So wouldn't your smaller universities be likely to be discriminated against in selecting that board, because you realize they don't have the endowment, they don't have the financial backing, and unfortunately, they don't pay the salaries. I wish in some way we could rate teachers regardless of what institution they are in, and pay them commensurate with their rating, regardless of where they are located.

Dr. SMYTH. A great many of the scientists from the big institutions have originally come from smaller colleges. As a matter of fact, that is a great practice for the institutions.

The CHAIRMAN. Isn't that one of the troubles in the teaching of science right now? You must realize that a lot of these boys will have to go to small institutions, and the girls too.

Dr. SMYTH. Perhaps I take too literally this "shall participate" phrase in here.

The CHAIRMAN. I am just trying to get ideas on it.

Dr. SMYTH. Let me put it this way: If the board in making a decision went through all its discussion and asked Mr. So-and-So to step outside while a vote was taken, if it was something affecting his institution, that would seem to me appropriate, but I don't feel the board ought to automatically exclude from its membership the people who come from the institution that will have to do the work.

The CHAIRMAN. Now I am getting the answer to my question. You see, I want you to expand and explain just what your idea is. That is the purpose of these hearings. If you say you don't favor a certain thing, we want to know why you don't favor it, and probably we can correct the mistake. We are doing a little laboratory work in here. I want to get your reason and what amendments or changes you think would fill up the objections.

Dr. SMYTH. Well, I have already covered my statement. I have, of course, no objection to preventing anyone from participating in a decision affecting his personal financial interests. Nobody in the university has any financial interests.

The CHAIRMAN. You think not? The teachers in my State university think they have a financial interest. [Laughter.]

Dr. SMYTH. I believe the instructions to the director given in lines 7–14 on page 7 are unnecessarily specific. In section 5 on page 3 I would suggest that the granting of scholarships should be on recommendation of a committee, rather than at the discretion of the director. I am dubious of the patent provisions in section 7d and e on pages 10 and 11.

The CHAIRMAN. Scholarships are one of the things that worry me. I know one scientist, whom you know very well, who has charge of a laboratory in Princeton. He comes from a small town, went to a small college; I was in high school with him, and we never thought he would be a top-flight scientist then. He was just a good, hard-plugging student. Eventually he became known. So the hardship of picking a high-school boy and sending him to be educated is something you should give a lot of attention to, to help us figure a yardstick for that.

Dr. SMYTH. That is why I said before——

The CHAIRMAN. On a population basis? Well, you will come fairly close, but not the way you should.

Dr. SMYTH. But at least pick the individual on a general-intelligence basis, rather than trying to see whether they will be great Edisons, or Einsteins, or authors, or what not, at that early level. That is my feeling; I don't know whether others agree with me. Later on you will find out which ones will be scientific, but you won't have wasted money if the boys you have given scholarships decide to go into politics instead of into science. [Laughter.]

The CHAIRMAN. That is an awful jump. No, you won't have wasted money; but I do think we should have some way of picking them. In that connection, some foundations are studying the interchange of scholarships, and have had a lot of experience, and we can benefit from that.

Dr. SMYTH. I am glad to see in section 9 the same provision about funds remaining available for expenditure for 4 years—that is in the Magnuson bill.

Turning to the revised Magnuson bill, I confess I don't understand this; I deplore the disappearance of a division of the physical sciences.

Senator MAGNUSON. May I say, Mr. Chairman, when we made this military provision we discussed it many times. We had a committee print of just the military, and this includes a couple of other revisions.

The CHAIRMAN. That was the one you just showed me. The only thing I saw was the amendment you put in there.

(Off the record.)

The CHAIRMAN. Go right ahead.

Dr. SMYTH. I take it that the work in physical science is supposed to be carried out under the division of national defense. There is a new provision inserted on page 6——

Senator MAGNUSON. Possibly you would like clarification on that. May I say, Doctor, this committee print is a work sheet, and there was introduced what is known as the Byrd bill, which took care of the military division and also there was introduced in the Military Affairs Committee of the House another bill, which we embodied in the so-called committee print, and we also make some other suggestions we thought might be changed, but it is all a work sheet, and the work sheet we are on now is mainly discussing 1285.

The CHAIRMAN. You mean the original S. 1285?

Senator MAGNUSON. Yes; and the reason for that science decision is it was to be left open, so that we could put in what should be put in.

Dr. SMYTH. This appears to put all of the research activities of the foundation, except medical research, under the direction of a group, that probably, in effect, will be preponderantly Government officers. I do not believe that this is desirable.

Furthermore, it seems to me quite out of proportion to have a division of medical research, but no division of physical sciences.

To sum up, I realize it is an extremely difficult problem to draw up legislation to meet the needs of scientific research in this country. Whatever the legislation is, its success or failure will depend on its administration. In contrast to my belief that the May-Johnson bill for the control of nuclear physics and atomic-bomb research will discourage research in this field, I believe any of the three bills I have been discussing can be made to promote scientific research in this country. As I have said, I prefer the Magnuson bill in its original form.

The CHAIRMAN. Are there any questions?

Senator SMITH. I will ask you the question I asked Dr. Compton. With regard to the social sciences, did you touch on that? I didn't hear the very end. I was writing a memorandum. You didn't touch on that mixture between the social sciences and the natural sciences?

Dr. SMYTH. I think possibly it is desirable to have at least scholarships and fellowships in the social sciences. I am more skeptical about attempting to set up in this bill a division of research in the social sciences, because, to my mind, it is very hard to limit it. I am not a social scientist, but, as Dr. Compton said, it is very hard to say what shouldn't come under that, whereas it is fairly easy to define

what you mean by research activity in the physical sciences. But, in line with my general idea that what you need it to get more people well educated, is the basis for scientific progress and every other kind of progress, and I would be glad to see scholarships established in the social sciences. I think they might be related with those in the natural sciences.

Senator SMITH. I have one more question about the atomic bomb, if I may. A suggestion has been made in some of the discussions I made on the bomb that the great cost of producing these earlier bombs was largely due to the experimental work done, some $2,000,000,000.

In the statement I think it was suggested somewhere that possibly now it has gotten to a place where it is reduced to very much lower figures, and the time may come when it will be so reasonably cheap to construct that almost any country, even the smallest, would have access to it when the time comes and everybody knows about it.

I would be interested to have your comments on the cost factor and whether that general observation is true.

Dr. SMYTH. I think that general observation is true. I think the great cost was very largely the result of pressure of time. We had to try, always, five or six different ways of doing something, because we had so be sure that we were trying something that would work. That, in itself, multiplied the cost enormously. The fact that we were always—that kind of thing spread all through the project—one constantly had to make decisions on the basis of inadequate information.

One had to design a big industrial plant on the basis of a few laboratory experiments which probably weren't even complete, and that kind of thing just runs the cost up enormously. I have heard, what shall I say, project gossip—I think is perhaps the fairest way to put it—which leads me to think the cost right now is not very great, in terms of the equivalent destructive power, and I do believe that the cheaper methods will probably be developed.

If you want to spend time enough, you can certainly disburse the plant, certain units of the plants could certainly be spread out so that you would have a small piece of it one place and a small piece of it somewhere else, so that it could be relatively well hidden, so that I think it is going to be very difficult to prevent other nations from developing the atomic bomb if they want to.

Senator SMITH. At reasonably low cost?

Dr. SMYTH. At reasonably low cost.

The CHAIRMAN. On the question of social science, Doctor, you heard the question I asked Dr. Compton. We have the case in which one of our own foundations made what might be called a social science survey of World War I, to find out what caused the defeat of Germany. They came to the conclusion it was a shortage of protein. They published a very massive document, which was taken by the German general staff and used in preparation for World War II. Then it went into the basic sciences. The Germans sought through basic sciences to find an answer to the things the social science survey had found. It looks to me as though the social sciences involve a tremendous public interest and probably the two have a near relation, that you could put them under separate heads and have them function properly together. One might aid the other.

Dr. SMYTH. I am sure there is a great deal of near relation and I do think that the scientists have, in the past, not sufficiently realized the social implications and the social obligations of their work.

The CHAIRMAN. The social implications have provided the incentive that has led to a lot of research work.

Dr. SMYTH. Yes.

The CHAIRMAN. Now the social scientists are trying to put that on a purely scientific basis; they assert the needs, by means of statistics and surveys and other methods, and the need is shown to the public with an attempt to solve it. Then when we attempt to solve it, usually you have to solve it by going into basic sciences or applied science.

Dr. SMYTH. Let me say this: I believe that our great problem—I am sure this is obvious to everyone—our great problems that we face are not the problems of the natural sciences, they are the problems of the social sciences, and of politics and of ethics, if you like. If it were possible to do, I think conceivably the best thing for the world would be to retire all the natural scientists, pension them off in pleasant places, or else put them to work on social-science problems—at least stop their research until the world caught up with them in a sense.

The CHAIRMAN. No. You must keep ahead with your basic sciences. You must keep ahead with the basic inquiry into the laws of nature, so that you know what law to employ when a social scientific problem comes up or how to modify that law to meet the problem.

Dr. SMYTH. I was exaggerating my position to make the point, but I do feel that social-science problems and political problems are of tremendous importance.

The CHAIRMAN. Don't you think social-science problems and political problems are one and the same thing?

Dr. SMYTH. I suppose so.

The CHAIRMAN. One other question. There has been a great deal of talk, you know, of planning some method of outlawing the atomic bomb. In light of your experience with the atomic bomb, and what you just said to Senator Smith, how could we word a treaty that would outlaw a bomb of that type of operation?

Dr. SMYTH. Well, I am sorry to say that I don't think we can. I think we have to prevent war. I don't think it means anything to talk about outlawing it.

The CHAIRMAN. Do you think the best thing to do is try to get an agreement to ban aerial bombs and winged missiles of all types and characters?

Dr. SMYTH. That might be desirable.

The CHAIRMAN. Then war would become of such a nature none would go into it.

Dr. SMYTHE. That won't work if people can develop atomic bombs.

The CHAIRMAN. We have to have a system to make sure they don't break the laws.

Dr. SMYTHE. I am sorry, I see nothing for it but stop fighting.

The CHAIRMAN. That is a social-science problem.

Senator MAGNUSON. Someone suggested the other day, I believe it was a Member of the United States Senate, we could outlaw the atomic bomb; we outlawed the use of poison gas. We fought a great war and apparently gas was not used.

I'd like to hear, Doctor, your comments on why gas was not used. My understanding is it was not used because it was not considered

effective. Do you think some of the ramifications of the atomic bomb, such as the rays mentioned here violated our international agreements not to use certain gases?

Dr. SMYTHE. I shouldn't think so. I think it is quite different. It is a legalistic point, really, and legalistically it is something quite different.

Senator MAGNUSON. Your point is that it doesn't make any difference how you kill, if you kill. The ramifications of social science have no end and you said you don't know where to stop. Nevertheless, giving this foundation authority to delve into the social sciences will give them authority, as Dr. Compton said, to pin-point some particular problem. Don't you think that is desirable?

Dr. SMYTHE. Yes, I do.

Senator MAGNUSON. You can segregate, certainly, scientific problems. For instance, it was testified here at the early part of the hearings it was probably fundamental this foundation have access to certain statistical information, which is in the realm of social science. They could take separate projects. It might aid them in their pure scientific research.

Dr. SMYTH. I would like to suggest a specific problem. Supposing we say we are going to have atomic bombs, have a war with atomic bombs. Then there is only one thing to do about it and that is to disperse our industries and disperse, decentralize, our large centers of population.

Now, that is a very definite social-science problem, to study how that can be done and how much it will cost, and things of that sort, and that is something I should think, if the foundation existed, it would be very appropriate for them to go into.

Senator MAGNUSON. I want to ask just one question, that I don't think was ever asked of any of these witnesses, and it is really our problem, but how much do you think this foundation should start off with yearly, just generally.

Dr. SMYTH. Oh——

Senator MAGNUSON (interposing). Well, for instance, let's, for the purpose of the record, OSRD spent 500 million in 5 years, and the National Research Foundation spent a contemplated scale of 10 to 15 million, in the first years, and in 5 years it would run about 120, 125 million. Would you think that this foundation should be greater in scope, in the way of spending money, than OSRD?

Dr. SMYTH. No; I shouldn't think so. It seems to me OSRD had to be extravagant in terms of doing things in a hurry. I also feel that we must be very careful in spending a lot of money on research in the next few years, not to kill the goose that lays the golden egg.

I am really concerned about how these big Government laboratories in Washington that are going to be proposed are going to be staffed and every industry is going to build a big research laboratory. How are they going to staff them, or try to, by taking them away from the universities? That means there won't be any new men trained in the universities and we will just run into trouble. I don't think—I think the limitation on what we do in research in the next few years in this country is more likely to be a limitation on personnel than on money, which brings back again the real purpose of this. It should be basic research, rather than applied.

Senator MAGNUSON. I believe so, and the training and research go very much together. The research goes best, I think, in a place where

young men are being trained, and keeps us awake. We have to teach them, and then the young men are being trained at the same time in a research atmosphere.

The CHAIRMAN. There is just one statement I want to make to clarify what Senator Magnuson said. Dr. Schmitz, the head of I. G. Farbenindustrie, quoted Hitler on the use of poison gas when some new gas was suggested to the effect that they wouldn't use it for fear of worse retaliation from the United States.

Thank you very much, Dr. Smyth.

Now Dr. Evans, the Librarian of Congress, has a prepared statement which I will put in the record at this point, since he is not able to be present.

PREPARED STATEMENT BY LUTHER H. EVANS, LIBRARIAN OF CONGRESS

Mr. Chairman and members of the committee, I welcome the opportunity to appear before the committee to present a statement of the ways in which my colleagues and I in the Library of Congress propose to assist the program of research in the natural sciences and the social sciences, and to inform you further of some of the facilities now available in the Library of Congress and in certain other governmental libraries.

I take it for granted, upon the basis of the testimony already presented to this committee and the reactions of the members of the committee to that testimony, that the committee is already convinced of the essential necessity for the scientist and the social scientist in this country to have readily available to him, under responsive cataloging and bibliographical controls, not only the scientific and scholarly literature of this country but also of all other countries. All types of knowledge constitute an almost unbroken unity which ramifies into all types of publications in nearly all of the languages of the world and in nearly all of the geographical areas of the world. To pursue research in any field to its furthest limits with efficiency and economy, a scientist or any other explorer into the secrets of the universe and of man's social life must be able to call upon any part of the record of human thought and human experience.

It is inconceivable that the sum total of recorded knowledge could be organized and made readily and certainly available to the demands of scientists and other scholars except through the creation of great collections of books and other publications in research libraries. Anything short of the development of at least one really comprehensive collection in the Nation is an ineffective and wasteful piecemeal measure. We in this country have, up to now, attempted to get along without a really comprehensive research collection, and I can testify, and any librarian can testify, and any research unit of a department of the Federal Government can testify that the Nation suffered greatly in time of war because of that deficiency. The reason was not that we did not believe in having a comprehensive research collection. It was rather that we did not realize fully how complete and how comprehensive it was essential for the collection to be in order to meet the demands placed upon it by the Government and the people in time of crisis. In other words, our concept of a comprehensive collection has expanded to such a degree under the force of extreme circumstances that my colleagues and I have come to the solemn conclusion that it would be necessary to build a collection on approximately twice the scale of the Library of Congress collection in order to achieve the degree of comprehensiveness required in the interests of this Nation.

I realize, Mr. Chairman, that this is not the committee before which such a program should be presented. I have felt it necessary, however, to give the committee this general statement of policy in order that it may appreciate fully what I shall now say about the Library of Congress in relation to the sciences.

First, as to the social sciences, it is my opinion that in law, economics, history, political science, and certain of the other social sciences the Library of Congress has a remarkably good and effective collection. This collection needs to be greatly increased and perfected in terms of the increased importance to the people of this Nation of developments in all of the other parts of the world, and we propose to increase the collection in terms of this need. There can be no question but what the Library of Congress is already so far ahead of other libraries in its social science collection that it should be the Nation's one greatest Library in the social sciences.

Now as to the natural sciences, I believe it is in relation to the natural sciences that this committee is most concerned regarding the adequacy of governmental support. It seems to be generally believed that the Library of Congress does not have a great scientific collection. I should like to inform the committee that there is an element of error in this conception which is perfectly understandable, in view of the fact that the Library of Congress has not given a specialized bibliographical and reference service on the books and other materials which classify under the scientific headings. What is needed more than anything else to make the Library of Congress function as a great scientific library is the addition of skilled professional personnel who would be able to perform this bibliographical and reference service which is so badly needed by the scientists of the country if they are to operate efficiently in their research activities.

I propose, Mr. Chairman, to submit to the appropriate committee of Congress next January supplemental estimates which would make it possible for the Library of Congress to employ the necessary professional personnel and to provide the necessary reference and bibliographical service. This personnel would also engage in acquisitions activities in order to fill in the serious gaps in the Library's collection of scientific material. Although we have over 300,000 volumes classified as science and approximately 300,000 volumes classified as technology, I believe it is generally agreed that these collections should be greatly enlarged. It requires subject specialists to take care of the acquisitions problem as well as to take care of the bibliographical and research problem. In the fields of medicine and agriculture, the Library of Congress has an additional 300,000 volumes, but it does not propose to develop comprehensive collections in these subject fields in view of agreements which have been arrived at with the Army medical library and the Department of Agriculture library, under the terms of which those libraries receive priority in the development of the fields of their specialization. The cooperative arrangements we have developed with those two libraries should make it possible for the three libraries to function in such smooth operating relationships that they become, for practical purposes, one integrated unit—a comprehensive national library proposing to subject all recorded knowledge to responsive control.

The development of our collections and services in the ways outlined above will make them of practical value to the proposed National Science Foundation in many ways. Let me point out two such possibilities. It is my understanding that one of the primary tasks of the foundation will be to survey the general field of science in order to find out what special fields need development and what problems are in most urgent need of solution. No such surveys can be conducted without ready access to the largest collections of recorded knowledge. It is the desire of the Library of Congress to make its collections available to the foundation for such purposes and in addition to serve as a repository for such new knowledge as will come from the foundation's activities.

A second way in which the Library of Congress can be of service to the proposed foundation is in connection with the dissemination of scientific information. For such purposes not only are our collections available freely to those who can come here to use them but they can be made available to workers at a distance The development of microfilm and other cheap and rapid methods of reproduction can place our resources at the disposal of an investigator no matter where he may be. Thus in these and other ways the Library of Congress can assist the foundation to accomplish its purposes of the increase and diffusion of knowledge among the peoples of the world.

Mr. Chairman, it is my honest conviction that the Congress of the United States fully appreciates the necessity of building such a comprehensive collection as I have mentioned, and that much greater results will be achieved, at much less expense, by developing controls over the world's literature in the way I have suggested than in any other alternative way.

The CHAIRMAN. The next witness is Dr. Urey.

Dr. Urey, will you identify yourself for the record?

TESTIMONY OF DR. HAROLD C. UREY, UNIVERSITY OF CHICAGO

Dr. UREY. My name is Harold C. Urey. I am from the University of Chicago. During the war I was in charge of the SAM Laboratory at Columbia University, one of the four large centers of research on the atomic bomb.

I might say that SAM is code for Special Alloy Materials, and Special Alloy Materials, in turn, is code for doing research on atomic bombs, particularly the separation of the uranium isotopes by diffusion methods.

My first work with the atomic bomb project was in 1940; and, in all, I have spent over 5 years on that problem.

In this introduction, may I say there has been no collusion betewen Dr. Smyth and myself. I have used the revised S. 1297 to refer to, since I believe it bears the names of both Mr. Kilgore and Mr. Magnuson.

The joint committee considering the National Science Act of 1945 has heard many statements by scientists on the importance of science for the public welfare. I agree with my scientific colleagues in their statements and think there is little disagreement with them anywhere.

I wish to direct my remarks to implementing these objectives. In order to illustrate a proposal for a change in the bill, I wish first to recount briefly the history of the development of the atomic bomb. This development started with the discovery of radioactivity by Henri Bequerel, Pierre Curie, and Marie Curie about 50 years ago. A very important step forward was made by Lord Rutherford when he first transmuted an element in 1917. The discovery of the neutron by Sir James Chadwick and the production of artificially radioactivity substances by Enrico Fermi were outstanding subsequent contributions in this field. The discovery of nuclear fission by Otto Hahn and Lise Meitner will go down in history as one of the greatest events in science.

The commercial exploitation of atomic energy for military purposes was carried forward in the United States during the war with almost miraculous speed because of the effective work of our own scientists and industrial companies.

You will note (1) that Europe furnished the fundamental scientific discoveries to a very large extent, and (2) that the United States supplied the industrial development.

This contrast between the relative strength of pure science and its industrial applications in Europe and in the United States can be illustrated in other ways. We are strong on application and weak in fundamental science.

The point I wish to make is illustrated by the statistics on the numbers of men who have received Nobel prizes in chemistry, physics, and medicine. These prizes are not the only measure of scientific excellence, as all scientists are well aware, but they are a significant index, since they are awarded without regard to nationality.

Here are the statistics showing the number of Nobel prize winners in the United States and in Europe:

	United States	Europe
Chemistry	4	37 (11 Germans).
Physics	8	39 (17 Germans).
Medicine and physiology	6	37 (8 Germans).

The relatively small number of Nobel prizes awarded to United States citizens indicates the weakness of this country in pure science and also, by contrast, its great strength in industrial development.

We have improved our scientific position during the past 25 years, but through all our history we have drawn on Europe for fundamental science. Our technical and industrial developments are the offspring of this imported fundamental science. Faraday through his work in pure science can be called the father of our entire electrical industry.

The great advance in technology comes only as a result of work in pure science in which the primary objective is an understanding of the fundamental laws of natural phenomena. At no time from the discovery of radioactivity in 1896 until about 1938 could anyone have asked specifically for the development of atomic energy into atomic bombs or power plants. Through all these years it was only the desire of scientists to understand natural phenomena which finally brought us to the stage where such developments could go forward.

The proposed National Science Foundation must move in a direction to offset this one-sided development of science in the United States. If it does not, it is not likely to make us strong in a truly balanced way. If I were speaking in Europe, I would advise a committee such as this to put first emphasis on industrial application. Speaking before this committee of our own Congress, I wish to advise that first emphasis be given to fundamental science.

To implement this emphasis I would like to suggest on page 2 of S. 1297, as amended, that the first objective of the bill be clearly stated as the promotion of fundamental science for the purpose of understanding the fundamental laws of nature and the training of men and women for scientific careers. Then the second objective should be stated substantially as in paragraph (a) on this page and paragraph (e) deleted. This is not a change in the bill's substance; I am only proposing a change in emphasis as between fundamental science and its application. Throughout the bill I would make similar changes to indicate the essential priority of the basic sciences by always listing them first.

I have dwelt in some detail on the purposes of this bill, for this section 2 is the charter of the foundation and fixes the direction that the foundation will follow.

There has been a great deal of discussion regarding the organization of the proposed foundation. Some advocate a commission, others a director. Yesterday Dr. Dunn proposed a Cabinet officer as the responsible administrative officer under this act. I believe that good administration can be secured under any of these proposals. However, I favor at the present time a director appointed by the President and removable by him for cause. I would like to suggest for the consideration of the committee the possibility that the director and deputy director each serve a fixed number of years, say six, with the possibility of reappointment. This makes a method available at regular intervals for review of the director's performance of his duties, with possible reappointment or replacement by the President. This proposal is intermediate between an appointment for an indeterminate period, as the present bill provides, and Dr. Dunn's suggestion of a director serving at the pleasure of the President.

My other comments follow an order which relates to the bill, not the order of their importance.

On page 10, line 1 and following, of S. 1297, as amended, are given directions for publishing the research findings of the foundation. This provision of the bill is good, but care should be taken to see that

it does not prevent publication except in some foundation-sponsored publication. I would favor an additional sentence in the paragraph stating that its provisions are not to be interpreted in such a way as to prevent scientific workers from publishing in established scientific journals if they so desire. In fact, it might be well to specify that such publication is desirable and should be encouraged by the foundation.

The CHAIRMAN. Do you think the purpose would be served if we would require things to be published in that journal,but refuse any copyright, so eventually the journal would become sort of a compendium. For instance, if John Jones had an article, and he wanted to publish it in one of the national professional magazines of the country, he would go ahead and publish it, but that would not preclude its being published in the journal. You know, under our copyright laws, sometimes you have to get permission to publish. The journal would have the right to publish anything out of any professional journal they wanted to, regardless of copyright, so the editorial staff could make it as near as possible an over-all journal.

Dr. UREY. I believe this provision of the bill can be used to great good for the distribution of scientific information. There are many ways in which it could bring together important information in certain fields and see that it is put out in a systematic way, and I think it would be well if the foundation would republish anything it published elsewhere, but our journals of chemistry, physics, biology, and so forth, have gone up in a spontaneous way that I think indicates the desirability of that type of publication.

The CHAIRMAN. I agree with you.

Dr. UREY. I am just trying to avoid injuring that method of publication.

The CHAIRMAN. For instance, if you publish an item of something in your scientific journal and we want it in the Congressional Record, we don't pay copyrights; we just clip it out of the journal and put it in without asking any questions.

Dr. UREY. I am only thinking if the research worker himself should not like to publish the article himself, somewhere else, there should be no objection.

Senator MAGNUSON. It was suggested by a witness yesterday, Dr. Griggs or Dr. Dunn, that at least this foundation should publish a catalog of the things it was doing so that would get wide distribution, so anyone could write for that particular article.

Dr. UREY. My remarks should not be interpreted here as in any way saying I do not approve of the provisions of that section of the bill, because I do. I only think a provision permitting publication elsewhere should be made at the same time.

Senator MAGNUSON. Or the foundation could, in its authority, subsidize. Now, Dr. Davis, when he was testifying, mentioned Scientific Service, which is a nonprofit organ; they could subsidize an article such as that, to catalog this, so it would be available to everyone, rather than actually publishing a journal themselves.

The CHAIRMAN. My thought was to broaden the scope, Doctor, in such a way that if it was deemed necessary to use an article that might not have been sponsored by the foundation, it could be done, not as an original printing but as a reprint.

Dr. UREY. I agree with that.

The CHAIRMAN. Go ahead.

Though not an expert on patents, it seems to me that there is a possibility that the development of certain patents may not be adequate. Inventions and discoveries resulting from Government-financed research are properly to be the property of the United States, but it might be possible to hold a useless piece of property. If a patent is taken out after the exploratory research is done, no means for manufacturing the product may be available because development problems remain to be solved and hence no use will come to the public from such a patent. There are some who say they cannot develop such patents because they have no protection to cover their cost of development. The patent would then come back to the National Science Foundation for development. I think it would be difficult for the foundation to do such work effectively. If the foundation should get into development work on a large scale, the appropriations for the foundation must also be very large, and unless this is the case, I fear that adequate developments would be difficult to make. I speak this way because of my experience during the war on the development of methods for the separation of the uranium isotopes. Development work must be carried clear through to the manufacturing stages to be finally effective. To go this far would place the foundation almost in the position of a manufacturer.

However, there are people in the United States who have had more experience in handling these problems than I. I am thinking of the Rockefeller Foundation, the Alien Property Custodian, and others. Perhaps they can give the committee better advice on this subject than I can.

I hope that we can keep these patent problems in proper perspective. After all, the fundamental purpose of this act should be to promote scientific research. I hope the foundation does not get far over to the development side, for I fear that fundamental science will suffer if this becomes the case. I refer again to my earlier discussion on what should be the primary objective of the act.

This foundation should concern itself, first of all, with the structure of spiral nebulae, the temperature of the center of the sun, cyclotrons, betatrons, the properties of mesons, and similar fundamental problems of science, and not with improvements in concrete or new structural steels, for example. I am only appealing here for a proper perspective.

I should like to express also my personal opinion that no university should engage in classified defense work. The primary functions of a university are education and fundamental research, and also education. Secrecy will interfere with advancement in the field of scientific research. Research coming under this act which is primarily for the national defense should be carried on in Government laboratories or industrial laboratories. I suggest a provision in the act that there be no secrecy regulations on any part of the work of the foundation unless at the time the contract is drawn it is specified that the work shall be so classified. Universities or other organizations will then know whether they are accepting a classified research contract.

We must depend upon the loyalty of the citizens of the United States ultimately for the protection of our country. This being so, I believe we can depend upon scientists to bring to the attention of the Government any incidental discoveries that might have military value.

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Again may I refer to our experience in the development of the atomic bomb in 1939 and 1940: A number of scientists walked the streets of Washington, knocked on the doors of various officials of the United States Government in order to convince these officials that atomic bombs were of military importance. Scientists will do so again when things of military importance result from their research. This is a far greater protection for the interests of this country than any system of security that can be set up.

I do not object to the security provisions in the bill, but some statement specifically protecting scientists from arbitrary administration of such provisions should be included. American scientists should not be subjected to the methods used by military intelligence during the past war. When information is voluntarily brought to the President or his representative and judged to require classification as secret or restricted, it should be so classified; but officers of the foundation or other Government security officials should not search out data and classify it without the consent and approval of scientists unless the project has been classified in advance.

The CHAIRMAN. I think, Doctor, you are hitting along my line of thought on this bill very closely. The primary objective of the bill, as I have always considered it, is in pure science. The defense feature is a necessary Government feature that must go along with it.

Now, the defense feature is applied science. The patents viewpoint on pure science, to my way of thinking, is merely to prevent somebody else taking it and putting patents on that basic idea that would preclude applied researchers from using the basic idea generally to get, shall we say, a mechanical application of it to needs.

Dr. UREY. Yes.

The CHAIRMAN. Of course, on the question of weapons, that has to be handled by contracts.

Dr. UREY. You mean the security provision?

The CHAIRMAN. That is why a National Defense Committee is set up, to decide what they want to go into, of a secret nature, and to protect the secrecy once it is developed.

Dr. UREY. My hope is that we will not have it.

The CHAIRMAN. In peacetime?

Dr. UREY. In peacetime, I do not believe that our universities should do secret work.

The CHAIRMAN. You must realize, Doctor, we are looking at this from a bad background. We are looking at it from these wartime restrictions, in which it was necessary to use university and college laboratories to do the work, that would not be done in peacetime.

Dr. UREY. There has been a great deal of talk on the part of people that have testified before this committee in regard to the great danger of secrecy in damaging scientific work.

What I am trying to say is not to go over that story again. The committee has certainly heard that often enough. But I am trying to suggest to you a specific modification of the bill that will accomplish that, no secrecy, unless the contract, when it is drawn, specifically says it is so classified, and we depend upon loyal American citizens to tell us if the occasional thing turns up that might have military significance. I think there is no question but that scientists will do that, as they have done in the past.

Senator MAGNUSON. In your experience in the so-called atomic bomb, at the beginning of this war, would the fact be borne out that

if someone happened upon something that did appear to be of military value, he would come in voluntarily here, to the foundation or the director, or whatever we set up?

Dr. UREY. Before any secrecy regulations were set up by the United States Government or any of its divisions, scientists in this country submitted themselves to a voluntary censorship. Remember, the war was not in progress when this started. We were not at war, and during that time there was a voluntary censorship on anything leading to the war by the scientists of this country.

The CHAIRMAN. You operated for almost 3 years under peacetime regulations, isn't that a fact? You started in 1939.

Dr. UREY. That is right.

Senator MAGNUSON. Wasn't there a voluntary turn-over of all patents involved in this matter?

Dr. UREY. No; I don't think so. I know of a couple of cases where it is not true.

Senator MAGNUSON. Were there some?

Dr. UREY. Patents were taken out in which no Government funds were involved whatever, and certain of the individuals felt those patents should remain in their possession, always willing to give a royalty-free license to the Government, and when I came across those cases, I felt it was none of my affair at all, since the work, so far as I could judge, had been done previous to the expenditure of any Government funds.

Senator MAGNUSON. When the Government funds were expended, then were they voluntarily turned over?

Dr. UREY. As soon as Government funds were expended, there was never any question of the matter so far as I recall.

Senator MAGNUSON. Doctor, there is a provision—it will probably be in the bill and there is in one of the revised drafts—for a military, so-called military division, a national defense division.

Do you think that would seriously handicap the foundation or would it be a protection to the foundation in keeping the military from coming in, as you say, and clamping down? Our attempt is to have the division itself justified.

Dr. UREY. I would favor a definite division to cover the military work. I think it would be a very definite advantage. Then it will be understood that all matters that have to do primarily with defense come in that division and are expected to be kept secret.

Senator MAGNUSON. Only for the purpose of the record and because sometimes you scientists are modest, I think the record ought to show, Mr. Chairman, that one of the four of those Nobel prize winners in the United States in chemistry was Dr. Urey.

Dr. UREY. I think that remark is quite unnecessary to include in the record. [Laughter].

The CHAIRMAN. If there are no further questions, we will excuse you, Dr. Urey.

Is Dr. Wolman here?

TESTIMONY OF DR. ABEL WOLMAN, PROFESSOR OF SANITARY ENGINEERING, JOHNS HOPKINS UNIVERSITY

Dr. WOLMAN. My name is Abel Wolman. By profession I am a sanitary engineer. I am appearing here, I think largely to present

to the committee certain phases of their activity in the field of sanitary engineering.

The CHAIRMAN. I am wondering, Doctor if you have a prepared statement?

Dr. WOLMAN. I do not.

The CHAIRMAN. All right, go ahead.

Dr. WOLMAN. I hope to make it brief. I am chairman of the Committee on Sanitary Engineering of the National Research Council, chairman of the Committee on Sanitary Engineering in the Pan American Sanitary Bureau, consultant to the Surgeon General of the Army and to the Surgeon General of the Navy, and officially professor of sanitary engineering at Johns Hopkins University, at the School of Hygiene and Public Health, and the School of Engineering.

I am afraid that I have to make somewhat of a supreme shift in the theme before this committee in what I have to say, from what the three preceding speakers have said I want to shift primarily, of course, from the field of destruction of lives and property to our particular sphere of operation where we are interested primarily in the salvage and reconstruction and rehabilitation of people and property.

My particular group operates primarily in the control and modification of the physical environment for the protection and improvement of public health, and perhaps the best way in which I can put before this group our particular interests is to outline eight or nine fields of activity in which we believe that we are short of or delinquent in research.

I ought to say in advance that we operate in a field in which applied research is more likely to be the significant factor.

Although I can subscribe with complete wholeheartedness to the emphasis which Dr. Urey places on the importance of fundamental research with respect to a proposed foundation, I subscribe to that heartily because I think any of the projects, which I list for you very briefly, must find their solution in, and must stem from the most abstract fundamental research.

I list them primarily because I feel the committee ought to have them before it and because they are of a pedestrian nature, so common in our everday life that they are likely to escape your interest and your attention in the field of applied activity.

The technical fields to which I want to refer, perhaps only listing them are, first of all, in water supply, reminding you we produce, either through private or public auspices, approximately 8,000,000,000 gallons of water a day, through organized community effort, publicly or privately owned. That is approximately 33,000,000 tons of a commodity a day. For those of you who like analogies, that means that the total annual steel production of the United States would be produced, in the water field, in about 3 days. The total coal production of the United States would be produced in about 21 days, in terms of equivalent weight.

We supply, as you probably know, something over 85,000,000 people with that particular commodity. I mention it in those terms primarily to indicate that although we have been doing that for a great many years and we believe with a reasonable degree of practical success, there are a number of projects in that field which still demand

a high degree of investigative activity in the field of physics and chemistry and biology.

The CHAIRMAN. There is a bill pending over in the House which gives income-tax credit to all corporations for waste-disposal plants, with the idea of purifying the streams. Do you think a thing of that kind is worth while?

Dr. WOLMAN. I am familiar with the bill, Mr. Chairman. I think it is worth while in the abstract. I would not have suggested its passage because I think it represents a specific field of tax compensation which might properly be applied in twenty, thirty, forty, or a hundred additional fields. I would like to feel that there would be some stimulation and there are several others.

The CHAIRMAN. The author, of course, is a great trout fisherman.

Dr. WOLMAN. I have a major topic here that deals with that particular field.

The CHAIRMAN. I was thinking of it from the human element.

Dr. WOLMAN. Yes; that suggestion of a tax exemption may be a sound device. I am not sure that particular field of activity should be singled out for the application of that device. I am told in the industry that expenditures in the field of stream pollution and abatement are frequently restrained or restricted and slowed down because of the tax problem, but I am sure there are other fields economically restricted or slowed down because of the tax problem. My only comment would be, as a matter of national policy, that that field, as others, should be related to the general tax problem, rather than be lifted out by itself.

In the field of water supply, I can't, of course, review all the things we don't know. I do want to record several things we don't know and should know.

During the last 4 or 5 years, in the military effort, was the first time in the history of disinfection or treatment of water that we arrived at any understanding of the destruction of organisms by chlorination. That may sound strange, because we have been practicing chlorination for nearly half a century. It took a war—and that is part of my theme I'd like to register—and the stepping up of the pace of investigation to disclose a fundamental basis of the activity of chlorine on organisms.

We know little or nothing, of course, about the effect of most of our common disinfectants on the virus diseases, one of the increasing fields of interest and curiosity and perhaps important practical application.

It took a war for us to find out what our problems in amoebic dysentery were, how they could be handled in the field, what the emphasis and importance of water supply, as a carrier of amoebic dysentery would be for our forces throughout the entire Pacific area.

It took a war to determine how to convert salt water to drinking water. It did more, however. It afforded us, through fundamental research, a certain important practical technique for tailor-making water for any purpose in use by industry, the domestic consumer, and others.

We are in a field where our fundamental knowledge is very limited. It modifies an applied program in the water supply program. It may be that the disease of children with respect to teeth, from the age of

5 to 12, may have its corrective factor in the application of materials and chemicals to water supply treatment.

The CHAIRMAN. The development of those things as applied research by industry have not kept pace with the needs, have they, and had it not been for the war, we would not have brought that up?

Dr. WOLMAN. The war has stimulated that very type of operation.

The CHAIRMAN. Do you think that type of applied research should be included with pure research in a national foundation?

Dr. WOLMAN. To my mind, it must be continued in peacetime, for two reasons: One, that I think the sharp separation between fundamental research and applied research is not as sharp, in my particular field, as it might be in theory, because out of fundamental research must come a number of these primary applications.

The CHAIRMAN. Don't you consider, also, your field has a certain part in what we call social science? A sort of a connecting link?

Dr. WOLMAN. I have been interested in the testimony this morning. I happen to have worked for a quarter of a century in a field in which intellectual isolationism with respect to science cannot persist and could not persist because our functions happened to be, purely by chance, the translation and transference of applied research as well as fundamental research to the welfare, the well-being, and the disease of individuals.

The CHAIRMAN. Here is another illustration of social science impinging on physical science. While it is really health research and medical research, in its pursuance, at the same time, it has a terrific effect upon the social sciences.

Dr. WOLMAN. Well, there are five or six stopgaps to progress in the field which I represent. One of them is the absence of fundamental research. The second is the absence of applied research.

The CHAIRMAN. For instance, in certain communities it has required a long educational program to make the people realize chlorination is for their own good.

Dr. WOLMAN. To expand my thesis, research is one part of our problem; an important part falls over very completely in the social-science field.

You mentioned stream pollution abatement. I want to say a word about it. The obstacles there are not only in applied research. They are in political administration, financial administration, political structure of the country, the various subdivisions of municipalities, counties, and States and interstates, which are almost a permanent block in the machinery of application.

I may, if I have the opportunity, extend that somewhat with respect to pollution abatement.

Senator MAGNUSON. For instance, in my State, there is a constant political fight every time the legislature meets, as to the question of stream pollution as against the pulp mills, until it got to the point where the State itself—one of the cabinet officers of the State is the director. There is a department for that express purpose. That is all they do. Couldn't a foundation such as this well aid, for instance, that State in working out that problem, both for the pulp mills and the State itself?

Dr. WOLMAN. Fundamentally, that is what has to be done, for this reason. In the pollution field—and I refer not only to the stream but

the air and other phases—it is never apparently the concern of industry to consider the social aspect of the waste. It is rather interesting, a beautiful explanation of why we are where we are with respect to pollution of the atmosphere. There the waste product is completely unnecessary to the other operation of the system.

The fact that they were damaging, socially damaging, damaging to fish, to wildlife, to water supply, to the general atmosphere, is a secondary consideration, which a foundation of this sort I think would be concerned with. It would have to stimulate both the industry and the State.

Senator MAGNUSON. That is what Senator Kilgore is pointing out. We have always thought the pulp mills in our State didn't give a tinker's damn what happened after they let the waste go. It isn't always true but there has always been the feeling.

Dr. WOLMAN. I think they give a damn, but not enough of a damn.

I may indicate this. I certainly don't want to appear here in relation to research and issue a universal condemnation of industrial operation, but I think it is true this country will be confronted in the next 10 years with approximately $2,000,000,000 of construction in the domestic and industrial waste field. That is a round number which we have approximated for one of your congressional committees. At least half of that is a bill for industry and a large part of that is a bill for a treatment or recovery process which is nonexistent..

The CHAIRMAN. Doctor, have you ever driven over route 16, past Smith River?

Dr. WOLMAN. Yes, sir.

The CHAIRMAN. Isn't that one of the most horrible examples of stream pollution in the United States?

Dr. WOLMAN. It is one. I could mention others.

The CHAIRMAN. You know the company there is known as the West Virginia Paper Co. and sometimes I feel it causes hostility between West Virginia and Virginia because the plant is in Virginia.

Dr. WOLMAN. Of course, I could list those fairly well scattered through the industrial areas of the United States. The reason for their lack of progress lies in the general fundamental research field and in the secondary applied field.

I am not prepared to say which is the major responsibility. I am prepared to say in the steel industry, in the pulp and paper trades, in the coal-mining industry, and the rayon industry, and the synthetic rubber industry, and the oil industry, we do not have the kinds of solutions we ought to have in order to accomplish what you are after in Washington, what you are after in West Virginia, what we are after in Maryland, or anywhere else.

Those solutions, by and large, are lacking. I presume they are lacking because there has not been the kind of incentive developed during the military period, when not only money was spent, but it was necessary to do something, and peculiarly enough the old adage, "Necessity is the mother of invention," worked. That is the condition we are in with respect to stream-pollution abatement.

Senator MAGNUSON. Your point is, a national research foundation such as this could very well aid in that problem, aid both industry and governmental units.

Dr. WOLMAN. Yes. I have no question about that at all. I think it is one of the fields in which we can do a tremendous service to society. It is not only a financial problem, it is a scientific one.

The CHAIRMAN. At that particular plant, and others of that kind, somebody discovered one time that the recovery of a certain solution, resulting from a mixture of something they call soapstone and the wood pulp and the acids, was the base for the finest face powders, so the result was they put expensive machinery in and recovered that solution.

I believe, also, they would find it to their advantage to recover the acids and use them. First they must be sold on the idea by research work.

Dr. WOLMAN. Even where we have solutions, both industrial and domestic, they are not always applied and they are not always applied because of money. They are frequently delayed in application. I could list a number of those in various municipalities, where the solution is clear, where the cost of correction is not great, and where the recovery values are great, and yet they are not instituted. That is simply a reflection of the inertia that accompanies a good deal of our activities.

There are, however, vast areas of industrial operation where the solutions are not clear, where the investigative resources have not been put on them.

There is a third group, in very large companies, incidentally, where the solution is not apparent at the time that the damage is being done and the threat of eliminating the industrial area brings forth a solution, a nonexistent solution perhaps 6 months before.

In other words, we have all types of examples which can be used in that case.

Senator MAGNUSON. And the foundation could properly direct its energies to that basic purpose.

Dr. WOLMAN. The foundation could direct its energies toward the basic studies, toward the stimulation of studies within the industry and governmental units. It can sponsor them by research fellowships. It can take all those things which at the moment are not the concern of anybody, which are not sufficiently the concern of industry and not sufficiently the concern of the Government and not sufficiently the concern of the research fellow because he doesn't exist or he hasn't the wherewithal with which to carry it out.

I refer to a third field because it is coupled with the stream-pollution field; namely, in atmospheric pollution. One of the great penalties of operation in any American city is atmospheric pollution. It differs from place to place. In the Southwest, where oil and gas are perhaps the common fuels, you can see the sun on occasion. In certain of our industrial areas of the East you can't see the sun very often. In the Middle West, the street lights may be on during a considerable part of the day and going up in a tall building you can see the sun shining in full, but on the street level it is not apparent.

What the health implications of that kind of situation are, we don't know. We do know we are not fully informed on the technological correctives with respect to smoke, with respect to dust, with respect to noise, with respect to conditioning of houses and public places of living.

I refer to the current distribution, production, and treatment of foodstuffs. We pretend that that is all in pretty good shape. On the milk supply, for example, it is disconcerting to report on this ground that within the very, very near past, we have had 400 cases of disease in Topeka, Kans., from an inadequately controlled milk supply, with the death of some 8 to 10 children. Why, in a modern society? Where are the social, organizational, financial, and technological things that are missing in respect to that application?

In the general food field, we are even worse. Of course, much of that control dropped down very rapidly during the war period. The dispensing of foods throughout the United States, even including the best establishments, does not do justice either to the kind of society in which we live or to the kinds of protection we must afford for the general public.

When we come to solid waste, we operate in a medieval stage. We don't know what to do in the way of salvage, in the way of recovery, in the way of technological advance, in garbage, in rubbish, or any other form of solid waste.

I said medieval. The procedure of collection, the procedure of disposal, the procedure of recovery, have not advanced one iota in the last 50 years. There, again, there is not sufficient interest in the technological phase to warrant pressing that toward any set of solutions.

In the animal and insect carriers of infection, I think it is fair to say more progress was made from 1939–40 to 1945 than in the preceding 100 years. I attribute it largely to the impact of the war. It has always been an interesting thing to me, in work in a field of public health, that it takes a war to develop a mechanism, a material, a commodity to salvage lives. It has been interesting to see the pace of investigation in that field was stepped up a hundredfold. It may be that in the discovery of DDT and collateral materials, we may solve problems in our country which we didn't think of touching over the previous hundred years.

Those kinds of studies have an important, practical application even though generally they stem from fundamental research. In the field of transportation, which I want to mention because it is one of the very interesting ones to me, and I think, Senator, should be to you, I want to recall a piece of history.

In the late nineties, the great Professor Sedgwick, of M. I. T., one of our public-health workers of that period, was employed by the city of Seattle, in Washington; and the professor at that time, in his wisdom, said he thought the method of disposing of sewage from the average railroad car was in 1896, or 1897, medieval. It is the same method today. The progress has been nil. Again it is a pedestrian kind of thing. Everybody is aware of it. The business of distributing human wastes over the countryside—and right here in Union Station—is still a common practice in railroads today in operation. I would like to see the foundation stimulate something which would improve that very limited, highly languorous phase of transportation activity.

Senator MAGNUSON. Let me ask you one other thing about transportation. Take a big city like New York, where they use these Diesel

busses. Does the odor from the discharge of those busses, which is obnoxious to me personally, and a lot of people, have a great effect upon your health, say, in a canyon like New York?

Dr. WOLMAN. Nobody knows. You will recall when tetraethyl lead first came into use in the field of gasoline application to the motor, a great deal of study was made, and it was concluded that its effects on health are probably slight. What the effects of the current discharges of all kinds of materials from Diesel engines, from ordinary motors, from smoke stacks, are on general health is quite an unknown factor. One of the reasons for its being unknown is that we have not the tools of measurement. It is interesting to note that we are passing through in that field the same phase we did in water supply. It is important to point out that water was treated long before we knew why we were treating it, excepting that it seemed to be desirable to remove mud and color, and in the process of treating, we ultimately learned the significant public-health advantage. The germ theory of disease which explained why we treat water came after the event, rather than before, and I am one of those who would like to see our atmosphere cleared up before we can prove that it reduces your efficiency 10 percent today.

Senator MAGNUSON. That gets down to the question I want to ask about this bill. Like Senator Kilgore, I believe that again stresses the importance of including in the bill social sciences, so that they can come to the foundation with just such problems to work out in basic research, but at least present the problem, and I presume from your testimony that you would strongly advocate the inclusion of social sciences. Although it covers a broad field, we could limit it.

Dr. WOLMAN. I would include them for this reason: I see tremendous importance in converting the results of fundamental and applied research to the uses of man. The reason I hesitate in defining how that should best be done, is the criteria, the method of measurement, the whole field of research in social sciences doesn't lend itself to the concreteness that it does in natural sciences. But I certainly would not underestimate its importance, because what such a foundation of science does in this field has, after all, whether we like it or not, significance not only in abstract knowledge, but significance in raising the general level of humanity, and that part of the program is a social-science enterprise.

Senator MAGNUSON. You would probably have it a separate division?

Dr. WOLMAN. Yes; because it is—because the level to which it has attained in its scientific method is of a different character, of a different quality, and of a different pace, but I certainly believe, as I do in any other type of activity, that the application of the kind of thing we learn, with respect to biology, physics, chemistry, which in turn is translated into medicine, and in turn is translated into engineering, needs to be put into public use.

The CHAIRMAN. Under what kind of a division should social-science studies pertaining to health and the well-being of the human race be? Should that be as social science, or health and medicine?

Dr. WOLMAN. No; I think it belongs in both, as a matter of fact.

The CHAIRMAN. In other words, there must be a connecting link?

Dr. WOLMAN. If you set it aside structurally, as might be desirable for managerial purposes, I certainly would provide for internal frequent interchange of discussion, of ideas, and of relationships.

The CHAIRMAN. I watched for some 12 years the development of a department in my State known as the department of public assistance. To start out with, the leadership came from one university in which they were carrying on social-science studies. They had one type of program. They had one standard criteria: Where you put an orphan child, and what you would do here and there. Then they changed directors, and eventually they changed a large part of their personnel to a university in an entirely different part of the country, and we had an immediate change in operational technic.

I was so interested that I went to both places, and I discovered their foundation studies were coming in both places from territory that was completely different from the territory in which this particular group were operating. So we now have our own social-science set-up that operates within the State, but there was an isolation, not an exchange of information, for instance, between, shall we say, X university and Y university and Z university. Each was proceeding on his own line. The trouble was that there was not the interchange of information between the three leading sources at that time.

Dr. WOLMAN. I see exactly what you mean. I might draw an analogy. For the last 10 years I happened to be the chairman of our State planning commission. Under that commission we developed a committee on medical care, largely, but not exclusively made up of scientists. I say not exclusively because it seemed to us, and it seemed to the medical group on that committee, that the development of adequate systems of medical care and hospitalization in the State of Maryland were not solely the province of the scientists—I mean the natural scientists. They were not solely the province of the physicians, nor in the technological application he makes, but in their social application other groups have to be brought in the picture.

The CHAIRMAN. To give you an illustration, after a short time in this change in policy, the judges and other public officials who had to deal with the agency became very hostile to it. It took a lot of study before you could convince them, and even yet some of the judges are hostile. If you want to start a case with some of the workers from such-and-such a university, the judge immediately gets his gavel and decides he will not have anything to do with it.

Dr. WOLMAN. I wanted to add just a word with respect to the international implications of the foundation. I feel that that work is essential even in addition to the things that have already been said by your previous witnesses, because in our particular field, distance is no longer a barrier against the dissemination of disease. We can't count on thousands of miles as any real protection. It is true, as the late Professor Whipple of Harvard said many years ago, "The world is bound in bacterial bonds." We can be isolationists in perhaps any number of directions, but not in respect to the passage of disease, and therefore, the foundation has a peculiar problem and a peculiar responsibility to my mind in establishing and maintaining consistently an international relationship in that field of science.

If science speaks a common international language, it speaks it every hour of the day and every minute of the day and every second of the day with respect to the diseases, and I wanted to record that particular fact. We can't isolate influenza, and we can't isolate malaria, and we can't isolate yellow fever. Whether we like or not, what happens in north Africa is a concern to the foundation.

Now, with respect to the bill itself, Mr. Chairman, I would not pretend to have any major suggestions to make on it. I did want to make one or two comments. The patent situation has been discussed by most witnesses, and I won't volunteer a suggestion as to the general patent situation.

I would say, in our own particular field, where large amounts of public funds may go into research for general application, by and large, I think those patents should be publicly held. That field may be a circumscribed one; it may be a peculiar one, and of course, it may be a restricted one.

The CHAIRMAN. Well, Doctor, there is a general misapprehension on the theory of the patents, that the Government is going to be a licensing agency. The theory is to protect it against somebody else getting the exclusive right and patents, to protect the public use of the results.

Dr. WOLMAN. The reason I put considerable emphasis on that, as a generality—I know there are always exceptions to that—is that in our particular field, over a period of 30 years, we have passed through a number of stages in which private patents holdings, most important ones frequently held in Germany, resulted in retarding the installation of sanitary devices in this country. Again this was due to the ingenuity and curiosity and I think in some respect the superiority of development in Germany, but if we are going to put public money in that kind of operation in our own country, I should like to see it protected at least to that extent, barring other contingencies.

With respect to the question of a single director or a board control, in such an enterprise as this, from the standpoint of administrative and managerial competency I favor the single director. I recognize the dangers attached to putting a single man in with the powers that reside in this kind of a foundation, and therefore, I would surround him, as you do, with an advisory board, which, however, has important continuing powers, several of which you provide for—one, that it must meet. One of the disadvantages of an advisory board in a public agency is that unless the legislation insists on their compulsory meetings, they are in the course of a year or so forgotten, and the director proceeds on his own.

Secondly, they should be not empowered, but requested and compelled to report independently through the Director to the Congress, so that you will not shut off judgments, opinions, criticisms, and such with which the Director is not in accord. But for managing it, I can't escape the fact that it must be done, in the simplest terms, by a single man. I am not so upset about that responsibility, because that is what we do in the Federal level to a large extent. The responsibility of this man, in a measure, parallels the responsibility of the Surgeon General of the United States Public Health Service. He has equal amounts of money, and it is handled through a single individual, who reports regularly to the congressional group.

The amount of money is not the measure of its importance; an alert public opinion, an alert advisory board, carefully selected for their distinction, should provide the only protection that I think we can provide. The endless adventure in search of a perfect syllogism of administration I can't get to. [Laughter.]

Senator MAGNUSON. No one else can, either.

Dr. WOLMAN. In over 30 years I have never been able to discover a substitute for the ordinary weaknesses of human nature—whether he is a Chief Executive or on an advisory board.

Senator MAGNUSON. It is like someone once said, "The best form of government the world has ever known is an absolute monarchy, if the king is right."

Dr. WOLMAN. It pretends to be the most efficient. We have learned it isn't. There is some advantage in inefficiency; it is a protection to the public. So I think on a dual basis, first, that you get advice, and it is compelled advice, which a Director must at least listen to, and which can find its route to Congress and to the public if he doesn't listen to it.

I have one other item, which may be a minor one, as it just so happens that the Federal Government, for a number of years, has considered a great deal of research. I am one of those who believe it carried on a great deal of very good research. I could mention names and I could mention functions and subject matter where their contributions have been of very high order. I don't know where it fits, but if those agencies, such as the Bureau of Standards, the Public Health Service, the Geological Survey, the Bureau of Reclamation, and the Corps of Engineers must in turn go through four and five sittings for their current funds, it would be unfortunate. I don't know if it is your intent. If it is, it should be clarified.

Senator MAGNUSON. I may say there that the purpose of these proposals is in no way to interfere with the agencies conducting research.

Dr. WOLMAN. Would they have to clear?

Senator MAGNUSON. No; it is a supplement.

The CHAIRMAN. This is for supplemental funds, if they have something for which they have no funds.

Dr. WOLMAN. This is the point I want to emphasize, I know they already must pass through five or six sieves.

Senator MAGNUSON. Or to come to the foundation with a peculiar problem they think maybe the foundation can farm out.

The CHAIRMAN. Or if they need money.

Dr. WOLMAN. As long as that activity is not given an additional hurdle for the amount of money it gets, because that hurdle is already great.

The CHAIRMAN. This is not to interfere in any way with their normal funds. It is merely to give them a possibility of getting something in the way of augmented funds.

Senator MAGNUSON. There is one other problem which bring us again up to date. I know you are conscious of it. But along the line you suggest, an immediate problem in the foundation would be the radioactivity from the atomic bomb.

Dr. WOLMAN. I had it listed. There is a whole field of unknown effects which must be added to the already large field of unknown

effects, in addition to radioactivity and any other form of change. What we are passing through I think is worth recording in our whole technological development in industry, as the introduction of new processes, frequently with new arrangements and chemical terms for which we in our field have neither measure of the factor or the effect. That is particularly true in the synthetic-rubber trade. It is true in the rayon industry; we don't know what to look for, nor do we know how to measure what it does.

Senator MAGNUSON. But a great reservoir in this country of basic science would, in your opinion, probably ultimately take care of those problems and make great progress.

Dr. WOLMAN. It is the key to our activities and I am not speaking in terms of simple applied researches. I am thinking in terms of primary, fundamental, basic research in the natural sciences.

Senator MAGNUSON. Someone said here today we excel in applied science, and it is more important to take action on these problems because the war, although it spurred scientists to do things, as you pointed out, has caused a great twilight zone in the development of basic science. It will be 10 years before we catch up.

Dr. WOLMAN. Yes. We have to adjust both the pace and the quality of our research.

The CHAIRMAN. Thank you very much.

(The hearing adjourned at 1:45 o'clock.)

HEARINGS ON SCIENCE LEGISLATION
S. 1297 and Related Bills

FRIDAY, OCTOBER 26, 1945

UNITED STATES SENATE,
COMMITTEE ON MILITARY AFFAIRS,
SUBCOMMITTEE ON WAR MOBILIZATION,
Washington, D. C.

The subcommittee met at 10:20 a. m., pursuant to adjournment on October 25, 1945, in room 457, Senate Office Building, Senator Harley M. Kilgore, West Virginia, presiding.

Present: Senator Harley M. Kilgore, West Virginia.

Also present: Dr. Herbert Schimmel, chief investigator; Mr. John H. Teeter, director of hearings for Senator Magnuson.

The CHAIRMAN. The committee will come to order.

Is Mr. Sargeant here?

Mr. SARGEANT. I am.

The CHAIRMAN. Mr. Sargeant, would you prefer to put your prepared statement in the record and give the highlights of it, or would you prefer to read your statement?

TESTIMONY OF HOWLAND H. SARGEANT, CHIEF, DIVISION OF PATENT ADMINISTRATION, OFFICE OF THE ALIEN PROPERTY CUSTODIAN

Mr. SARGEANT. I would like to read some of it, but to save time I will summarize the latter part.

The Alien Property Custodian, Mr. James E. Markham, has asked me as Chief of the Division of Patent Administration to report to this committee some relevant points of the experience which our Office has acquired in the administration of Government-owned patents and inventions during a period of more than 3 years. The invitation extended to the Custodian by Senator Kilgore, Senator Magnuson, and Senator Pepper and their respective subcommittees requested the general views of our Office "on the development of a national program for scientific research with particular reference to the problems of Government patent policy and utilization of research findings."

Since March 1942 the Office of Alien Property Custodian has been administering thousands of patents and patent applications and other forms of industrial property vested from nationals of enemy and enemy-occupied countries. One of the first problems which confronted the Custodian after the entry of this country into World War II was the seizure and administration of patent property owned by the enemy. At that time we knew very little about the problem. We knew only that the enemy, particularly the Germans, owned

great numbers of United States patents and that the inventions covered by these patents should be brought into full use in our war program. In April 1942 we outlined a patent policy to the Senate Committee on Patents and pointed out that it was necessarily tentative. Our permanent policy was worked out during the following months.

Our primary objective in the administration of industrial property has been to make it available readily and immediately to serve all American industry and science. We intended to foster the active use of the store of technical knowledge represented by these patents and applications for patent; and we wanted to encourage further research on these inventions.

The experience of our Office bears directly only upon certain aspects of the proposals now under consideration by this Committee. My testimony today is limited to those aspects with which we have been directly concerned: The administration of enemy patents and the dissemination of technical information. Our experience in these limited areas, however, has led to some conclusions which I believe are of immediate interest to this committee.

The CHAIRMAN. At that time, most of the patents which had been administered by your office were patents either placed, secured in the United States by Germans, or procured by German companies from American patentors, and most of them were under license to American companies or German-owned companies at the time you took them over, isn't that right?

Mr. SARGEANT. The figures we have show, Mr. Chairman, that about 33,000 of the patents that we took over were enemy-owned. We feel that about 22,000 were actually licensable under our policy—that is, that only 11,000 were actually licensed in some way to other people. That is about a 2 to 1 ratio.

The CHAIRMAN. The only ones you operated were the ones you found at that time were not under license to American manufacturers?

Mr. SARGEANT. Yes; not under exclusive license.

Now, the things we may have had experience in that bear on the present proposals are first, in administering these patents you just described, and two, the dissemination of the technical information these patents represent.

The CHAIRMAN. Did you find to a large measure that the patent application itself was not sufficient, that in addition you had to get technical know-how in order to operate, because the wording of the patents didn't give sufficient know-how to operate with?

Mr. SARGEANT. We made a survey of a number of our licensees on that point, Senator KILGORE, and we found that there was a lack of sufficient know-how in a number of cases. One group of 24, which I mention later in this testimony, showed difficulties which ranged from inability to prepare working drawings from the patents due to the fact that there was not sufficient disclosure to inability to determine the most effective range of temperature and pressure conditions to operate a process.

The CHAIRMAN. Go ahead.

Mr. SARGEANT. Now, I think I would summarize our conclusions rather briefly. One, we are in complete sympathy with the proposals to create a National Research Foundation to secure the full development and application of the nation's scientific and technical resources.

Two, our experience in administering patents which have become the property of the United States Government leads to the conclusion

that it is desirable to define specifically in any legislation that is enacted the broad principles under which the administration of patent rights would be carried on by any agency created to execute a national program for the adequate development of our technical and scientific resources. We believe that will be applicable to such an agency as you are proposing here, as the National Research Foundation.

Our third conclusion is, our own experience leads me to the conclusion that a Government agency will make the most effective use of the patent rights under its control through the adoption of a policy of nonexclusive, royalty-free licensing, which is in fact, the program the Alien Property Custodian has been carrying on.

We also conclude the adequate development of the inventions and discoveries disclosed in the enemy patents and patent applications vested in the Custodian required us to devise effective techniques of dissemination. To bring technical information owned by the Government into effective use demands an active participation by the Government in the creation of such aids and tools as will serve to make the raw technical data actually usable by the scientists and businessmen of this country.

Our last conclusion arises from our participation in a program of republication of foreign scientific literature during the war and the results of that program confirm the needs for Government support of an organized program to obtain wider dissemination of scientific and technical information originating abroad.

We feel the program carried on by the Alien Property Custodian is definitely related to the objectives proposed for the National Research Foundation. On a small scale we have been engaged in a business of compiling and maintaining a comprehensive inventory of findings resulting from scientific investigation in certain foreign countries. We have been attempting to promote a rapid introduction and fullest use of the most advanced techniques, inventions and discoveries which have been under our control. I would emphasize we have not engaged in the business of entering into direct contractual agreements for the support of research and development.

Our experience is confined to those problems we have encountered in attempting to obtain the maximum use by American industry of technical knowledge of enemy origin, for the most part disclosed in vested patents and patent applications. We have attempted to do this by means of a nonexclusive royalty-free licensing policy and by an active program of dissemination of the technical information disclosed in the patents and patent applications we have seized.

The CHAIRMAN. Let me ask you a question at that point which was brought up in hearings some 2 years ago on the question of royalties on these foreign-owned patents. We have had brought to our attention recently in another committee a request by certain American companies that in the resale of goods, surpluses, covered by foreign patents and domestic patents, that where that was license-free to the Government, we should remit the royalty fees if we resell them to American citizens or to foreign countries, or as a part of our surplus-property proposition.

You remember after the last war American companies paid considerable royalties to a number of foreign patent holders—for instance, the interest on the steel formula and things of that kind. Is there a tendency on the part of American licensees at the present time to claim

that we are going to have to pay these foreign licensees for the material made during the war?

Mr. SARGEANT. Senator Kilgore, I have not noticed such a tendency myself. You are aware of the fact that a number of these patents we took over were already under exclusive licenses, agreements made before the war between enemies and nationals of this country.

The CHAIRMAN. And if they continued to operate that way, unquestionably we would have had to pay the royalties for them to the foreign owners of the patents through the manufacturers in this country that had the exclusive licenses?

Mr. SARGEANT. Correct. As it has been, you understand, the Alien Property Custodian has stepped into the shoes of a former enemy, and where a firm has maintained that exclusive position, we have collected the royalties, but for the United States Treasury, and that, I think, amounts to something over $10,000,000 so far.

The CHAIRMAN. On that particular type, where there was an exclusive license?

Mr. SARGEANT. That is right.

The CHAIRMAN. On the nonexclusive what have you done?

Mr. SARGEANT. We have relatively few cases of nonexclusive royalty-bearing licenses. Where they have existed, we have collected royalties there, and offered licenses on comparable terms to any other businessman that wanted to practice that invention.

The CHAIRMAN. And have you recovered that in the Treasury, too?

Mr. SARGEANT. Yes, sir; that is correct.

The CHAIRMAN. With that bookkeeping in evidence, will it not be possible for foreign patent owners to come in after the war and claim that we are just really trustees for those funds?

Mr. SARGEANT. Well, Senator Kilgore, I think that depends on what you gentlemen of the Congress will set up as a policy for this postwar world. Certainly after the last war, according to the provisions of your Trading With the Enemy Act, there were such suits, as you will remember, whereby the enemy owners were permitted to come into court.

Now, I think there must be a determination in the reasonably near future as to what position the Congress wants to adopt for the treatment of such people.

The CHAIRMAN. Then you agree with me that there must be some action taken by the Congress of the United States on that very subject, else we face the same situation in the future?

Mr. SARGEANT. Yes, sir; I think there is a real possibility of that.

The CHAIRMAN. In other words, under the Alien Property Custodian's powers, there is nothing he can do except act as custodian?

Mr. SARGEANT. You will remember, in the Trading With the Enemy Act, a series of amendments after the enactment of October 1917. It has become a piece of legislation that really needs overhauling, and some of that is already contemplated by a bill which has been introduced at the request of the Departments of State and Justice and the Alien Property Custodian, to take care of certain portions of it, and our feeling in the office has been that a logical plan is to take care of the most pressing needs, in presenting them to Congress immediately, and at some time when there is a little more leisure we do feel that the whole concept of the statute should be looked into and overhauled. Our patent-licensing policy, when it was adopted, aroused a great deal of controversy.

The CHAIRMAN. I want to ask one other question. Under our present law, those patents were seized for the duration, isn't that right?

Mr. SARGEANT. No, sir; I know of no limitation whatsoever. The patents were seized to be held and used in the interest of and for the benefit of the United States, and there is no restriction.

The CHAIRMAN. But as to use for commercial purposes, that comes into a different category, doesn't it?

Mr. SARGEANT. I don't know how you can really distinguish, Senator Kilgore. Certainly, as we point out here, the statute under which we operate gives very little guidance to the Alien Property Custodian as to how those patents should be administered. It says to him, your job is to see that this property is held and used in the interest of and for the benefit of the United States. Anything that you can determine is a reasonable interpretation of that language, for commercial use or war use, is within your powers.

The CHAIRMAN. What I am getting at is this; here are, say, 33,000 patents, or whatever we have.

Mr. SARGEANT. Right, sir.

The CHAIRMAN. We have seized them under special legislation of that type. Do you feel that under that legislation this is a seizure which runs into the postwar period or should there be some other step taken? For instance, here is a patent on synthetic rubber, we will say—although there never are just a group of patents on synthetic rubber. We have been using it for the production of rubber for the war effort, which is a phrase I don't like, but for the maintenance of the country during total war. Now, peace having come, the large use of those patents would be in a commercial way in the civilian economy.

Mr. SARGEANT. Absolutely right.

The CHAIRMAN. In no way connected with the war. Is that act sufficient in itself to go ahead operating that way, or must there be some other step?

Mr. SARGEANT. Senator Kilgore, so far as I know, our legal department has never felt there was any impediment to using these patents freely either for war or postwar use, for commercial or military use. They feel the statute will amply cover that use.

The CHAIRMAN. On an international basis, is it your feeling that something should be done in the treaty with reference to our action on that?

Mr. SARGEANT. I think it is probably very desirable to take certain steps in connection with a peace treaty. There are a number of loose ends that will otherwise be left dangling with respect to this patent property we have taken, and I hope when we come to such a thing as a peace treaty, we will be prepared to deal with it pretty effectively at that time. You will also have other problems which are going to arise from this technical information that we have obtained direct from the German plants and laboratories, both by following up the combat troops before VE-day and subsequent technical investigations. All of that should be considered part of a general topic.

The CHAIRMAN. It seems to me that the way this will be handled in the future should be a subject for treaty considerations.

Mr. SARGEANT. You will remember also that in certain foreign countries, such as Great Britain, the patent laws have operated some-

what differently than ours with respect to patents that were held by enemy nationals at the beginning of the war.

For example, this spring when I was in London, I talked with the head of the British Patent Office, and Mr. Saunders told me that because of their provision that at the end of a certain period of time, which I believe is about 3 years, every owner of a patent in Great Britain must pay certain annual fees to maintain that patent, that by their refusal to license enemy payment on such patents during the war, the majority of the enemy patents no longer exist. They have fallen into limbo, so that we come to the end of the war in a different situation than Great Britain, for example.

The CHAIRMAN. Another evidence of the fact that our patent structure should be reformed in some way.

Mr. SARGEANT. A number of people would agree with you on that. When we adopted our nonexclusive royalty-free licensing policy, we aroused a great deal of controversy in this country. It was an unusual policy. There were two things that were perhaps not fully realized about it at the time of its initiation. First, we did not adopt this policy lightly; we only adopted it after the most careful study of alternatives. Second, we made an attempt to grant royalty-free, nonexclusive, revocable licenses under all patents which were seized from enemy owners and in which no American claimed an interest. Where Americans have bona fide interests in or under vested patents, these interests are, of course, respected and the policy followed must be adapted to the requirements of the individual case.

The CHAIRMAN. If you remember, prior to the war, and evidently in anticipation of it, certain Farben patents were conveyed in toto in the United States to a domestic corporation owned partially by Standard of Jersey and partially by I. G. What was the policy in reference to those patents, to treat them as domestically owned patents, or foreign-owned?

Mr. SARGEANT. I am not certain I know which transaction you are referring to there, Senator Kilgore.

The CHAIRMAN. You remember Standard-I. G.?

Mr. SARGEANT. Yes, sir.

The CHAIRMAN. It was formed in this country partly as a cloak for those general patents, and of course a percentage of the stock was owned by American capital in the form of Standard of Jersey, and a portion owned by I. G. Farben capital, German capital of I. G. Farbenindustries. What was the policy in reference to that type of cloak?

Mr. SARGEANT. I believe you are referring primarily to patent rights in Jasco, and what came to be called Standard Catalytic. You will remember that on March 25, 1942, which was within 2 weeks of the appointment of Alien Property Custodian in this war, a consent decree was entered into in which the Custodian was a party, with Standard of New Jersey, which provided for a compulsory royalty-free licensing during the period of the war emergency of many of those patents.

The CHAIRMAN. I know that very well, because, if you remember, they could not get a consent decree in the subcommittee of the National Defense Committee. There were plenty of newspaper reporters present—finally a consent decree was entered into. However, I have not had time to study fully the consent decree. Does it

recognize the cloak as being an adequate one behind which they can hide?

Mr. SARGEANT. I would say it does not, although I would say it was a very complicated problem. The consent decree contained a number of ambiguities which resulted in a series of negotiations between the Alien Property Custodian and the Standard company. As a result of those negotiations, we took a position that the Custodian, on behalf of the United States Government, actually held full title to a number of those patents. Standard Oil maintained we were in error; they brought us into court. That suit is still pending. Hearings were held last spring.

The CHAIRMAN. You recognize, of course, the fact that while we got the right to use the patent, we had to do all the necessary research work to find out how to use it, because the cloak was such a thin cloak, that it didn't even have the know-how attached, and there was no way of getting it, so it was necessary for us to develop the process, which was just as big a job. It really means more than the patents.

The patent licensing was just a guaranty that there wasn't going to be any more lawsuits on it, whereas the know-how made it necessary to get the rubber. You couldn't run an automobile on lawsuits. You say the suit is still pending?

Mr. SARGEANT. Yes, sir.

The CHAIRMAN. There has been no determination of whether or not that is a successful method for an enemy operating in this country?

Mr. SARGEANT. No, sir. That has not been specifically determined.

The CHAIRMAN. As I remember, Standard had 60 percent of that stock, and the I. G. interest had 40; is that right—giving control to American interests?

Mr. SARGEANT. I am not certain what those percentages were. I think it was either that or 50–50. In Standard-I. G., I think the relationship was somewhat different from the Jasco relationship.

The three main points about our patent-licensing policy were, first, that it was not exclusive, second, that it was royalty-free, third, that the licenses were revocable licenses.

We have granted nonexclusive licenses from the beginning. If the Custodian were to grant exclusive licenses he would be faced with the problem of deciding to whom the exclusive privilege should be given. If several competing firms each wished to obtain an exclusive license the Custodian would have no basis for determining which should be chosen. If the Custodian undertook to grant exclusive licenses to the highest bidder he would be likely to find himself in the position of being forced to grant the monopoly privilege conferred by an exclusive license to a large firm simply because a small businessman or one about to start a new business could not offer as high a bid.

Many persons, nevertheless, insisted that exclusivity is necessary for the fullest exploitation of patents.

The CHAIRMAN. At the time there was such a great demand you couldn't tell if there were still people that thought you should have an exclusive license to make it; isn't that right?

Mr. SARGEANT. Yes; that is right.

We were not in the position of knowing everything about the problem. We thought possibly they were right. We offered to grant exclusive licenses for limited periods to applicants who would bear the burden of proving that such exclusivity was necessary for the proper exploitation of the invention. This offer we have had outstanding for 3 years now, but no person has yet made a formal application on this basis. Seven persons or firms, however, made preliminary applications for exclusive licenses under 20 patents and applications for patents. In each case the applicant expressed a desire to have exclusive rights in order that development costs might be recouped.

Our decision to license the vested patents without charging any royalties for their use was not made lightly. It was finally made for two major reasons. First, preliminary experience indicated that it would not be administratively feasible to negotiate reasonable royalty rates under the large number of patents held by the Custodian. The concept of "reasonableness" as applied to royalty rates is an uncertain one and it is subject to no precise definition. We have patents in practically every field and we do not have and cannot get the technical competence to make realistic appraisals of their possible commercial value. It was our purpose to encourage the widest possible use of patents rather than to get the largest possible monetary return from them. The President has recently reaffirmed the general policy of the Administration to make freely available to the public technical information developed with Government funds or obtained as the result of exploitation of the plants and laboratories of enemy countries. (See Executive Orders 9568 and 9604.)

The CHAIRMAN. Have you figures at hand to show how many of these patents were exclusively licensed in the United States, at the time we entered the war, to companies whose dominant stockholding was German?

Mr. SARGEANT. Senator Kilgore, I don't have those figures here. I would be very glad to try and supply them for the record.

The CHAIRMAN. Also, how many of those patents were licensed to American corporations that were bona fide corporations, owned by, or at least dominantly owned by, American stockholders.

Mr. SARGEANT. I don't have them with me, but I think we can supply those figures.

The CHAIRMAN. But there were a great number of patents licensed to American corporations, were there not, that were foreign-owned?

Mr. SARGEANT. Yes, sir; that is quite correct.

The CHAIRMAN. I wonder if you would put that in the record.

Mr. SARGEANT. I will do that, Senator.

The second compelling reason which persuaded us to adopt a royalty-free licensing policy was our conviction that since the patents had become the property of all the people of the United States they should be available to all on the simplest basis possible. Most of the royalties paid by the American users of the patents could be expected to be passed on to the consumers of the articles manufactured or indirectly to the taxpayers. Thus the burden of paying the royalties would fall ultimately on the public; in effect, the Custodian would be obtaining income from the public by an indirect and expensive method.

The CHAIRMAN. Incidentally, would it be possible for your office to furnish for the record the amount of royalty that would have accrued

on these patents, based upon manufacture, had we permitted them to go ahead on a royalty basis, thereby adding to the cost of the war?

Mr. SARGEANT. Senator Kilgore, I will tell you frankly, it will be a crystal-ball estimate.

The CHAIRMAN. It will have to be an estimate; I realize it is too big a job to get it down in dollars and cents.

Mr. SARGEANT. We will do that.

The policy of royalty-free licensing has worked smoothly and, I believe, successfully. Its economic benefits, although most impressive on the basis of reasoning, are not capable of measurement. But its administrative advantages are a matter of record; the manpower needed for correspondence and negotiations with prospective licensees and the actual issuance of licenses was a small fraction of what would have been needed for the administration of a policy of royalty-bearing licensing.

Some persons who had been critical of our policy of licensing without royalty charges when we first embarked upon it have become satisfied that their apprehensions were not warranted and that royalty-free licensing is a good policy for the Government to pursue with respect to patents which it owns.

The licenses issued by the Custodian under vested patents are revocable. Revocability appears under present laws to be a necessary concomitant of the royalty-free policy. Since the patents are property of the United States Government it is doubtful that the Custodian has the power to make, through irrevocable licensing, a permanent disposition of them without consideration. We are convinced, however, that the grant of irrevocable licenses would foster far greater use of the patents.

As far as I know, this is the first public attempt we have made, Senator Kilgore, to appraise with complete objectivity what has been accomplished, and from the results, I would say, personally, that the policy has been satisfactory. The results have far exceeded the predictions of even the most optimistic of those who formulated this policy in the spring and summer of 1942.

We have seized a total of about 33,000 patents and patent applications from enemy owners. Of these, perhaps 22,000 are free from claims of interests of Americans and can, therefore, be regarded as licensable under our standard policy. Of course, many of our patents are old and have never been licensed because they have never had any commercial value; others were once valuable but are now obsolete. Nevertheless, counting each patent as often as it has been licensed, we have licensed more than 10,000 patents in 1,700 separate licenses. While these patents relate to scores of different fields the field of greatest interest to licensees are those of machinery and chemistry.

The CHAIRMAN. I don't know whether you had an opportunity to observe it, but by competitive licensing, did you discover different companies would develop different techniques which might probably improve the product?

Mr. SARGEANT. Yes; we do know of instances where companies have operated exactly that way, licensed under the same patents or same group of patents.

The CHAIRMAN. For instance, we found Packard built the Marlin engine on a Rolls-Royce design with about 50 more horsepower, with

the same weight, which improved the manufacturing technique they use.

Mr. SARGEANT. I may say that we don't know as much as we would like to know about the use of these patents, because we have tried to make this licensing just as simple as possible. We don't want anyone to take a license and go through thousands of dollars of bookkeeping and accounting to conform to our requirements under royalty-free licenses, so we don't ask for detailed reports; we ask for a very general annual report from our licensees. We do find some interesting things from that.

The CHAIRMAN. Doesn't that arise from the fact that your interest was the production of material for wartime needs, and that in so doing you accomplished the purpose of your office, and that the bookkeeping end of it was of minor importance?

Mr. SARGEANT. I think that is a fair statement of it, sir.

Now, the general reports we get show some things I think of particular interest to the committee considering a National Research Foundation.

Ninety-five percent of the patents licensed and reported upon were licensed to firms in 11 States, with the largest numbers in Massachusetts, Ohio, and New York. Of the 504 reporting firms, 137 were companies with assets of over $5,000,000, while 101 companies had assets of less than $250,000. The reports indicate that research work had been done on about 1,100 patents during 1944 and many licensees indicated that they intended future research on the patents included in their licenses. It is significant in my opinion that reports from groups of smaller companies, that is, companies with less than $1,000,000 assets, indicate that about 50 percent of the patents licensed to them were actually used in production or were the subject of research during 1944. Reports by larger firms indicate that at least 25 percent of the patents under which they had licenses were actually used in production or were the subject of research.

I won't attempt to draw hard and fast conclusions, but I think those are indicative of what Government may do under a large holding of patents where you adopt this nonexclusive royalty-free type of licensing policy.

I would like to summarize the latter part of this report, if that is satisfactory to you, Senator Kilgore. Very briefly, I will say that we took over a large number of about thirty-one hundred patent applications from German and Japanese owners. These were pending in the Patent Office when we took them over. We didn't know whether we should prosecute these, or whether we should allow them to be abandoned. We did our best to find out what the desirable policy was, and finally, decided we would prosecute them before the Patent Office, in order to have patents for the public's benefit, and in order that the possibility of private parties appropriating the ideas contained in the applications and obtaining patents on them for their own use might be avoided.

We appeared before the Patent Office under exactly the same conditions as any private inventor. Our applications are granted and we are given patents if the Patent Office finds the inventions are patentable. And our applications are rejected like anyone else's if the invention is without merit. We have been granted roughly eighteen hundred patents out of this group. We have abandoned

the prosecution of nine hundred or more when we became satisfied that the ideas were unpatentable, and the remaining cases are still pending.

We also did one thing that was again highly unusual; as soon as we had taken over these patent applications, we published a résumé of the technical contents, so that anyone in the United States would know immediately during the war what was contained in them. Otherwise they would have been held secret in the Patent Office files during the period of prosecution. That apparently was a policy that was extremely successful in bringing to the attention of people who were working in our production program the new ideas. I think perhaps——

The CHAIRMAN. Mr. Sargeant, I was very much interested in the reasoning behind your prosecuting those patent applications, and that was to prevent somebody else from taking the results and letting them by default be refused. That was to get the opportunity to license nonexclusive, royalty-free patents; otherwise they might have immediately drifted into an exclusive situation a little later.

Mr. SARGEANT. On the best advice we could find—and I may say that the advice was not unanimous; it was not clear-cut—we felt that the preponderance of opinion of the experts who knew the problem was to avoid that possible danger of drifting into a monopolistic position. We felt we should prosecute these patents and obtain them for the Government.

One of the problems which will confront a National Research Foundation will be the acquisition of rights in inventions from inventors and the problems of the respective equities of inventors and the foundation in inventions developed with Government funds. In this area the Custodian has had no experience. Our patents were not developed with Government funds, and we have made no contracts with inventors. We merely seized such enemy patent property as we found. When I speak of the Custodian's patent policy, therefore, I am referring only to the policy followed in administering patent property, not in acquiring it.

The CHAIRMAN. But, Mr. Sargeant, isn't it fair to say for the record that the Custodian's office has been successful in administering patents on a royalty-free, nonexclusive basis?

Mr. SARGEANT. I would like to feel that the public would subscribe to that statement. I personally believe it.

The CHAIRMAN. Don't you think the results shown show they can do that?

Mr. SARGEANT. I feel that personally; yes.

The terms and conditions under which the Custodian administers patents in his possession are not specified in detail by law, beyond the injunction in the statute to administer vested property in the interest of and for the benefit of the United States. Our principal objective is to obtain the widest possible use of seized patents. The Custodian has fixed the policies for administering this patent property in accordance with the best collective advice he could obtain as to the most effective means of carrying out that injunction. While the grant of broad discretion to an administrative officer to make policy of this kind is particularly useful when great flexibility is needed as it was at the outbreak of the war, there is much to be said for writing into a statute at least the main points of policy to be followed in the

administration of Government-owned patents. In the first place, the range of possible policies is very wide and the administrator needs the assurance that the particular policy which he is following does, in fact, reflect the wishes of the Congress.

Second, any patent policy which is adopted needs to be followed for a considerable period of time, since rapid changes in policy can cause great difficulties to users who must make plans covering the whole life of the patents. A policy fixed by Congress is likely to have more stability than one fixed by executive action and patent users can place more reliance in its continuity. Third, many questions of the scope of the authority of the administrator arise where a policy is not fixed by statute and these questions are frequently difficult to resolve. For example, we are convinced that licenses under vested patents ought to be irrevocable except for cause, but in the present state of the laws under which we operate we do not appear to have the authority to make them so.

It is not my intention to recommend that an administrator be hampered in the effective administration of Government-owned patents by inclusion in legislation of minute details of policy. Rather, I am suggesting that it has been our experience that necessary discretion may be effectively exercised by an administrator operating under broad principles and standards clearly defined by statute.

Our experience in disseminating technical information confirms the wisdom of providing in the contemplated legislation for wide powers to disseminate research findings. The great reservoir of technical information contained in the 33,000 vested enemy patents and patent applications, in my opinion, would have remained largely unused had we not taken a series of related steps and employed a number of different techniques in order to make this information of real use to small as well as large business.

Our first step was to prepare and publish a catalog showing the number and short title of each vested patent, grouped according to the 300 Patent Office classes. Simultaneously we issued an index to serve as a guide to the catalog and to acquaint the public with our licensing policy. Up to the time that these catalogs were replaced by an even more useful working tool, the public had paid us $44,000 for 6,300 complete catalogs and 12,000 separate sections.

The catalogs of short titles of patents were merely an immediate means of enabling a prospective user to find his way among our patent holdings. The short titles of the patents in themselves, however, were usually of no great value in disclosing the true nature of an invention and many potential users were discouraged over the necessity of frequent reference to printed copies of the patents themselves which were often not readily accessible. Accordingly, we made plans to publish abstracts of the vested patents. We did this in two publications, one covering the chemical patents and the other giving abstracts of the mechanical and electrical patents. The immensity of this task should not be underrated. In the preparation of the abstracts of the chemical patents alone, we were assisted by the voluntary participation of more than 250 members of the Chicago section of the American Chemical Society and by some 50 members of the science-technology group of the Special Libraries Association.

Public response more than justified the time and effort expended in the preparation of these abstracts. Evidence of this, besides the

almost unanimous enthusiasm of scientists, industrialists, and patent lawyers, was the actual willingness of the public to buy these abstracts at a price which covered the cost to the Government. The public has paid us $43,000 for the chemical abstracts, consisting of 33 sections, on orders of 1,169 complete sets and 3,547 sections up to September 30 of this year. The public has paid $40,000 for 1,182 complete sets and 4,070 separate classes of mechanical-electrical abstracts in a little more than a year. We have made special efforts to invite libraries, universities, chambers of commerce, and cooperating branches of the Government throughout the country to purchase these abstracts so as to make them as widely available as possible. Some 180 public and semipublic organizations with 270 offices in 48 States have acquired copies of one or both of these publications and in many cases are carrying on an active public relations program, urging potential users to come in and consult the abstracts.

I have already described the publication of the technical data contained in the pending applications for patent immediately after the seizure of these applications by the Custodian.

We also carried on patent exhibits in cooperation with the Smaller War Plants Corporation. We had technical representatives, who are familiar with the patents, presenting to the public in 37 key cities in the country exactly what our policy was and how some of the patents could be used in the war program. More than 25,000 people registered at these exhibits during the year in which they were held.

We also established permanent patent libraries in Boston, New York, Washington, Chicago, Kansas City, Portland, Oreg. In some cases we put technical representatives into the areas to help the reconversion problems and that was a reconversion from peace to wartime production at the time we started. We find that it now works in reverse and that we are beginning to help on reconversion problems to peacetime industry.

The CHAIRMAN. Mr. Sargeant, I was very much interested in what you said about reconversion. This group of 22,000 patents, or 33,000, whatever it is that you hold, if they are permitted to go back to the old ownership and all licenses now revoked, in effect, and thereafter exclusive licenses granted by the foreign owners, would that aid or retard reconversion?

Mr. SARGEANT. In my opinion, you could do nothing more harmful with these patents in retarding reconversion than to permit such a policy to take place.

The CHAIRMAN. Could you do anything much more harmful to the reconversion program?

Mr. SARGEANT. I would seriously doubt it, sir.

The CHAIRMAN. For instance, you mentioned a little while ago 101 small companies in one group that were carrying on research in 1944 based upon these patents.

Mr. SARGEANT. That is correct.

The CHAIRMAN. Some of them had not gotten fully into production yet. They would lose all the results of that research.

Mr. SARGEANT. Correct.

The CHAIRMAN. As well as the big companies, the 137 large corporations that were carrying on research. That would be lost, if, for instance, one of them was able to gobble up all the patents.

Mr. SARGEANT. That is absolutely right.

The CHAIRMAN. So that reconversion for the plants involved there might wreck the plants, if their rights that have accrued so far were taken away from them. I think it would be a definite set-back to American business to break up the policy on this block of patents.

Mr. SARGEANT. I think that is right, sir; I think also there would be some question of keeping good faith with the American people in this case, since clearly the whole tenor of the administration of the patents so far has been that a man takes a license which will make him free for the remaining life of the patent to operate on it.

The CHAIRMAN. Now, Mr. Sargeant, going one step further, if what we hope never happens should happen, and we should get involved in another all-out war, and and should drop back to the old policy, instead of pursuing as we are going now, do you believe we would be able to get companies to pick up these foreign patents just to produce during the war unless we paid them some terrific expense items?

Mr. SARGEANT. No, sir; I don't think so at all. I don't think they would do it.

The CHAIRMAN. In other words, in your opinion, these companies have gone in here in good faith, in a purely competitive field, to manufacture things under these patents, and it hasn't been just an effort to get something for nothing? It has been a good faith effort on their part, and therefore, their activity would be severely handicapped if that good faith were broken by the Government?

Mr. SARGEANT. Their activities would be severely handicapped. I think they would lose substantial sums of money. We don't have complete information on what the value of the production was. We know that on a basis of reports from an incomplete group of our licensees in 1944 they made more than $150,000,000 worth of products under these licenses. Maybe that is not a large figure in wartime.

It is incomplete and many of the most important contracts were under war secrecy, so that they could not report the full extent of their business.

The CHAIRMAN. And some of them was on a cost-plus basis, where it was impossible to report?

Mr. SARGEANT. Undoubtedly so.

I think you make a very important point, though, and I would underscore it, that there could be nothing more disastrous than to return these particular patents either to enemy ownership or to return them to some type of exclusive position.

I will summarize very briefly the last two points. I have indicated that we had to use some unusual techniques in order to make this information usable. We now have a program in operation whereby we have sought the cooperation of industry in screening out the worthless from the valuable inventions. We do this primarily through the technical committees of scientific societies and trade associations. We have nearly 100 such projects for evaluating patents in important industrial fields now under way, with resulting reports to be distributed generally to anyone who wants to use them.

I would say one thing about small business. Our program was founded on the idea that we would have to find new techniques to make this information actually useful to small business people. We

have worked very closely with Smaller War Plant Corporation; we have done a number of things which I have already indicated, such as holding direct conferences with small manufacturers, getting the assistance of local chambers of commerce, in addition to the SWPC organization. We have reviewed our entire patent holdings and selected 1,500 patents that are especially suitable for production and development by small business. We think that these techniques have been at least partially successful—a lot of people have written us and told us how it has helped them in some particular problem.

At the present time we are finding that many servicemen are coming to us, and we are particularly anxious to help them. Fifteen percent of our patent inquiries in the Washington office in August were from servicemen and in September 24 percent of all patent inquiries came from people either still in the armed forces or recently discharged from there, and we hope that from this experience we will be able to assist many of the veterans to find a useful industrial process or technique that they can use in going back to private business.

The CHAIRMAN. I can verify that. One group came to me who were going to pool their resources and they were looking for a small plant building some place and something to make. They were all men of technical training. I think there were 12 of them and they were going to borrow their maximum limit and form a company to make some item, and I remember that I referred them to your office, to investigate as to anything they might make, and also to the Defense Plant Corporation. I thought possibly they might have some building they could sell them. But I do have that one instance in which a group of men who were capable of doing work through their technical training, were pooling their resources and trying to go into business for themselves.

Mr. SARGEANT. Senator, earlier in the morning, you asked whether some of these patents did not lack sufficient disclosure to the point of being inoperable. That is quite true. We find this is not necessarily a malevolent use of the patent system. We understand when you take out a patent on the basis of laboratory finding you may not know the conditions that are necessary for large-scale operations. Our patents we have found in a number of cases lacked the necessary know-how. I think we have done one thing to help remedy it.

Through the Technical Industrial Intelligence Committee, under the Joint Chiefs of Staff, we have asked teams of technical experts actually operating in Germany, where most of these patents of ours originated, to try and build up that know-how so that we can pass it to our licensees. We are also supplementing this by building up from other sources a file of know-how and other technical data relating to the patents. This will in a measure alleviate it but it will never cure it entirely.

The point I would make is that in any agency to be created by this proposed legislation, you should empower that agency to teach actual know-how pertinent to the research development supported by the foundation. If you don't carry that through to the actual stage of use and large-scale development, I am afraid that much of it will never be serviceable to industry and science in this country.

The fifth conclusion that I mentioned early in my testimony was that in your legislation you propose a wider dissemination of technical

and scientific literature. We have had some experience in this field because we discovered after the outbreak of war that in this country there was a great demand for German scientific literature, to be used in connection with our armament research program primarily. In order to meet this demand, we undertook a program of licensing the republication of enemy-originated scientific books. We also undertook to reprint current German scientific periodicals ourselves.

We licensed for republication nearly 700 of these scientific books and we ourselves published about 3,200 issues of about 116 current foreign scientific periodicals. We distributed them to the leading research centers in the country, including Government libraries and laboratories, industrial laboratories where there were defense contracts, and so forth.

We are preparing at the present time a full report on our participation in the dissemination of enemy technical literature. We expect to present it to the President within the next few days. I believe, Mr. Chairman, that the committee would find this report of real interest to them in considering this problem of the dissemination of technical information of foreign origin.

The CHAIRMAN. When it is completed, will you furnish the committee with one?

Mr. SARGEANT. We will be very happy to do that, sir.

It was evident from our experience that: (1) Such a republication program as we carried on was of tremendous value to our scientific workers in this country. (2) It was also evident that it is now necessary for this Government to provide the funds and I believe to assume leadership in reproducing important foreign technical literature now. Otherwise, we are going to have very serious gaps in our collections, due to the ravages of the war years and the fact that through our secret channels we were never able to get out all of the information from Germany and the other enemy countries that we could have used in this country.

I have taken longer than I meant to in this presentation, sir, and I will end it there.

The CHAIRMAN. I have lengthened it somewhat by questions.

In discussing the patent features of S. 1297, and you understand the draft is a guinea pig draft, there are two methods under which patents could be handled by the Government, in my opinion. One would be the method in which you handle nonexclusive free- licensing, or royalty-free licensing. The other would be a patent in the name of the people, requiring no licensing at all; just anybody could come to the library, get the data, and start manufacturing.

Which, in your opinion, would work the most efficiently for the public welfare?

Mr. SARGEANT. It would be my honest impression, Senator Kilgore, that the method of obtaining a public patent and not requiring a licensing procedure would be, in the long run, the most effective. I am not certain that you would want to adopt that immediately. You might want a transition period in which you experimented with that policy of licensing with the full understanding that you would move to a dedication policy, which is really what your latter proposal envisages.

The CHAIRMAN. The latter proposal, to my mind, does not envisage necessarily a patent as a piece of property.

Mr. SARGEANT. I understand that.

The CHAIRMAN. It envisages a patent as something preventing somebody else taking an exclusive right to a public development that would interfere with the public's use of it.

Mr. SARGEANT. And, really, isn't that the philosophy that the Custodian, for example, has operated under? But your foundation will be able to operate without some of the handicaps that required licensing on our part.

The CHAIRMAN. Certainly. I realize that.

Mr. SARGEANT. If we had not had, for example, the claims of Americans under the patents, of exclusive licenses and proprietary interests outstanding, the possibility of future return of property to enemy owners, and so forth, I feel sure——

The CHAIRMAN. In other words, if you had not had the uncertainty of the postwar policy laid down in the bill, you could have operated much more efficiently?

Mr. SARGEANT. Yes; and I think we could have operated in large areas without the necessity of going through a licensing procedure.

(Additional information submitted by Howland H. Sargeant:)

NOVEMBER 1, 1945.

DEAR SENATOR KILGORE: When I appeared before your subcommittee on October 26, 1945, you asked me if I would supply certain figures for the record. I agreed to attempt to do so although I stated at the time that some of the figures would have to be rough estimates.

1. Number of patents exclusively licensed in the United States at the outbreak of the war to companies whose dominant stockholding was German.

The normal procedure was for German parents of American subsidiaries to transfer their United States patents to the subsidiaries instead of merely licensing them. In a few cases, however, licenses were granted. Nineteen companies, of which more than 50 percent of the stock was vested as the property of Germans, held title to or licenses under approximately 6,200 United States patents. This figure does not include approximately 675 patents and 100 applications for patents involved in the current litigation with Standard Oil Co. (New Jersey).

2. Number of patents vested from enemy owners subject to exclusive licenses to bona fide American corporations.

In June 1942 we required all persons having an interest in enemy-originated United States patents to report such interest to us. We have not divided the reports of interests as between claims of exclusive license and other claims but it is estimated that about 8,000 enemy-originated United States patents which have been vested by the Custodian are subject to claims of exclusive license.

3. Amount of royalty which would be accrued if licensed patents had been licensed on a royalty basis.

Our reports from licensees do not call for detailed production figures and a considerable amount of production has been done under conditions of secrecy. It is consequently almost impossible to make an estimate of the dollar value of products manufactured under vested patents. From such figures as were furnished by licensees, we know of $150,000,000 worth of products manufactured under licenses in 1944. Perhaps one-half of the total was reported. If production under these patents in 1943 was one-half that of 1944, and if production for the first 6 months of 1945 was at about the same rate as 1944, there is an indicated manufacture of $600,000,000 worth of products. Assuming a reasonable rate of royalty to be 5 percent, this would indicate that the royalty might have been $30,000,000. I must again point out, however, that these figures mean little or nothing, for they are based on totally unsupported assumptions and, regardless of the amount of

manufacture under a royalty-free policy, there is no assurance that a similar amount of production would have taken place if a royalty had been charged.

Very truly yours,

HOWLAND H. SARGENT,
Chief, Division of Patent Administration.

OFFICE OF ALIEN PROPERTY CUSTODIAN,
Washington, November 21, 1945.

Senator HARLEY KILGORE,
Chairman, Subcommittee on War Mobilization, Committee on Military Affairs, United States Senate, Washington, D. C.

DEAR SENATOR KILGORE: I am enclosing a copy of my report to the President on the program of republication of scientific periodicals of enemy origin, which program was recently concluded by this Office. I thought you might find this report of interest. For your convenience, I am also enclosing a short summary of the report.

This is the report, a copy of which Mr. Howland H. Sargeant promised you when he appeared before the subcommittee of the Committee on Military Affairs on October 26, 1945.

Very truly yours,

JAMES E. MARKHAM,
Alien Property Custodian.

REPORT ON ALIEN PROPERTY CUSTODIAN PROGRAM OF REPRODUCTION OF FOREIGN SCIENTIFIC PERIODICALS

Highlights of the report follow:

Need for enemy scientific literature.—During the war it was necessary to obtain and use information regarding activities of enemies along scientific lines just as it was necessary to know what their military activities were.

Attempt to meet demands for journals.—The European war had not immediately cut off the receipt of scientific literature from European countries, but by May 1940, nothing was available through regular channels of supply. The effort of American library associations to import this material failed when the United States entered the war.

APC establishes republication program.—Early in 1943, acting on the advice of a committee of experts, the Alien Property Custodian assumed the responsibility for the task of furnishing industrial and research organizations with foreign scientific periodicals. A basic list of 125 journals was established and the APC completed arrangements for the reproduction of these periodicals and the distribution of them through regular trade channels.

Size of the program.—During the operation of the program, the Office of Alien Property Custodian had reproduced 116 titles, consisting of about 3,200 separate issues.

Value of the program.—The program of reproducing and distributing German scientific literature benefited American science. For example, the editor of *Chemical Abstracts*, Dr. E. J. Crane, informed the APC: "There is not the least doubt in my mind of the fact that your republication program was one of the factors which made the atomic bomb possible." Iowa State College, which received an Army-Navy E for atomic bomb research, reports, "The men working on this splitting of the atom used, to a considerable extent, the periodicals which you have reprinted." Ninety-four percent of the subscribers utilized the journals for war use. Subscribers included industrial concerns, scientific institutions, universities, research organizations and United States Government agencies.

Cost of program.—Printing costs to the office were less than gross subscription income. No definite allocation of general overhead costs have been made, but subscription income has been sufficient to retire all costs of the program.

Reproduction of foreign scientific books.—Reproduction of foreign scientific books was licensed to commercial publishers on a basis calculated to encourage the most extensive publication and dissemination. Nearly 700 books were licensed for republication.

Assistance and personnel.—Original copies of the journals were supplied to the office by the Interdepartmental Committee for the Acquisition of Foreign Periodicals, which operated under the Office of Strategic Services. Columbia University made its facilities and personnel freely available for use in the project.

Report on Periodical Republication Program, Office of Alien Property Custodian, November 1945

The Office of Alien Property Custodian was created to seize enemy property in this country and to administer it for the benefit of the United States. One valuable property of enemies was the right to control, through copyrights and otherwise, the distribution of much enemy-originated scientific literature. Acting under the authority given him, the Custodian has seized these rights and, through a program of periodical republication, has made available to American scientists throughout the war much of the results of German technical research, both that published just before the war and that published during it.

I. NEED FOR ENEMY SCIENTIFIC LITERATURE

During the war it was necessary to obtain and use information regarding activities of the enemy along scientific lines just as it was necessary to know what his military activities were. Scientific research in Germany was far advanced; recently a group of eminent American scientists stated:

"If Hitler had prevented the publication in 1939 of the first papers on atomic fission, Germany might have remained for a certain period of time in exclusive possession of a true fundamental secret of atomic power." [1]

American experts in the scientific field needed ready access to foreign scientific information to buttress scientific research in this country and to keep informed of the results of such research in enemy countries. Scientific literature from enemy countries was in such demand before the war that industrial and research organizations, scientific societies, and libraries annually spent approximately one and one-half million dollars for foreign books and journals. Most of this was spent for German publications.

II. ATTEMPTS TO MEET INDUSTRIAL AND RESEARCH DEMANDS FOR JOURNALS

The problem of obtaining the results of foreign scientific research was most acute when the Office of Alien Property Custodian was created. The European war had not immediately cut off the receipt of scientific literature from Europe. After the German occupation of the low countries in May 1940, however, practically nothing was available through the regular channels of supply. The few shipments intended for this country were usually either lost at sea or impounded by British censorship officials at Gibraltar, Trinidad, or Bermuda.

To meet the need for a continuous supply of scientific periodicals from Europe, attempts were made by library associations to import small quantities of the needed periodicals and to distribute them to industries, research organizations, and libraries by a careful system of allocation. This effort, never more than partially effective, failed entirely with the entry of the United States into the war. Attempts were also made to microfilm scientific reports obtained from enemy sources, but these attempts also met with failure, for distribution and utilization of the microfilm proved to be impracticable.

III. THE OFFICE OF ALIEN PROPERTY CUSTODIAN ESTABLISHES THE PROGRAM

By the summer of 1942, it became imperative that some governmental agency assume responsibility for reproducing enemy-originated scientific publications and make them available to American users. No arrangement short of republication could fill the need and no American publishing organization could be found which was willing to undertake the economic risk and administrative inconvenience inherent in a program of the required scope. Early in 1943, therefore, the Custodian assumed responsibility for the task.

Before undertaking the program, the Custodian sought the counsel of persons interested in dissemination of scientific information and appointed an advisory committee. The members of the committee were:

Dr. E. J. Crane, editor of Chemical Abstracts.

Watson Davis, president, American Documentation Institute.

[1] Statement of Drs. David L. Hill, Eugene Rabinowitch, and John A. Simpson, Jr., prepared at the direction of the executive committee of the Atomic Scientists of Chicago and quoted in Life magazine October 29, 1945.

Luther H. Evans, Librarian of Congress.
Thomas P. Fleming, chairman, Joint Committee on Importations.
Miss Sarah A. Jones, librarian, Bureau of Standards.
W. H. Kenerson, executive secretary, National Research Council.
Frederick Kilgour, executive secretary, Interdepartmental Committee for the Acquisition of Foreign Periodicals.
Waldo Leland, director, American Council of Learned Societies.
Keyes D. Metcalf, then president of the American Library Association.
Paul North Rice, executive secretary, Association of Research Libraries.
E. Wilder Spaulding, chief, Division of Research and Publication, Department of State.
Donald Young, executive director, Social Science Research Council.
George F. Zook, president, American Council on Education.

After consultation with the committee, the Office of Alien Property Custodian put into operation a complete periodical republication program which included the selection of materials to be reproduced, procurement of original copies of journals, the execution of reprinting and subscription contracts, release from paper quotas, the announcements of available material, and the establishment of other arrangements assuring the widest possible dissemination of the more important war-urgent foreign scientific journals on a regular and continuous basis.

A basic list of 125 journals was established. Both current and back volumes were considered for republication. The policy of reprinting back volumes was adopted to close gaps in American holdings of foreign scientific journals and to satisfy research demand occasioned by references in current reprint journals to articles in earlier issues.

The Office of Alien Property Custodian completed arrangements to have the journals in question reprinted by a private photo-offset printer, and established subscription prices for the journals at a figure approximating the prewar subscription prices. During April 1943 the subscriptions were offered to approximately 8,000 firms and individuals engaged in the war effort, selected from lists compiled by the National Research Council and the War Production Board. Usual trade channels were used in the distribution of the republished journals.

IV. SIZE OF THE PROGRAM

Throughout the entire program, the Office of Alien Property Custodian continually explored the need for various types of journals and at the termination of the program had offered 138 journals for subscription, on the recommendation of scientists and other competent research interests. Of these, 116 titles were actually reproduced. In all, about 3,200 issues, comprising all or parts of 282 volumes, have been republished.

V. THE VALUE OF THE PROGRAM, THE MATERIALS COVERED, AND THE PERSONS AND FIRMS BENEFITED

It was, of course, reasonable to expect that the enemy journals would not reveal exact specifications for the latest antiaircraft equipment or give detailed descriptions of such weapons as the V–1 or V–2 bomb. It is clear, however, from the nature and quality of the materials printed that the German Government throughout the war continued and in some cases even intensified its peacetime policy of encouraging publication of scientific information. The advatages of this kind of dissemination, within Germany and territory occupied by the German Government, as a means of expanding scientific frontiers were obviously considered by the German Government to outweigh the possibility that such information would become generally available to scientific personnel among the enemies of the Reich. The benefits of basic German research in many fields were thus made available to American science. In some cases materials in enemy journals have been of direct and immediate use in military operations. For example, an article in VDI Zeitschrift, concerning engineering problems in constructing German camps was directly utilized in construction of Army barracks.

More frequently, however, the subject matter in the articles served primarily to reveal the trend of enemy research and basic facts which confirmed previously held theories, thus saving thousands of man hours of painstaking investigation. Moreover, such materials presented theories and concepts which were tested on the basis of American experience, and thus became valuable in the war effort. To illustrate, frequent articles in Die Naturwissenschaften and Zeitschrift fuer

Physik concerning atomic fission and uranium 238 were effectively utilized by scientists engaged in the Manhattan district project. The editor of Chemical Abstracts, Dr. E. J. Crane, has informed us "There is not the least doubt in my mind of the fact that your republication program was one of the factors which made the atomic bomb possible." Iowa State College reports "This college has received an E for its research on the atomic bomb * * *. The men working on this splitting of the atom used, to a considerable extent, the periodicals which you have reprinted."

The journals reproduced dealt with almost every phase of scientific development of interest to a nation at war. Included among the journals were the leading periodicals in the following fields:

Acoustics	Geophysics	Paper chemistry
Aluminum	Infectious diseases	Parasitology
Aviation	Immunology	Pathology
Biochemistry	Instruments	Petroleum
Ceramics	Magnesium	Pharmacology
Chemistry	Mathematics	Physics
Crystallography	Mechanical engineering	Plant pathology
Electronics	Metallurgy	Plastics
Engineering	Microscopy	Rubber
Enzymology	Mineralogy	Spectrochemistry
Explosives	Mycology	Steel and iron
Fermentation	Nutrition	Textiles
Geology	Oils and fats	Virus research

An analysis of the nature of the subscribers in the program indicates the extent to which foreign scientific literature was actually used for war purposes. Forty-eight percent of the subscribers to journals reproduced in the program were industrial concerns; 33 percent were scientific institutions, universities, and similar research organizations; 8 percent were agencies of the United States Government, and 5 percent were industrial concerns, government agencies, or research institutions in the British Empire. Nine-four percent of the subscribers utilized the journals for war use. The remaining 6 percent included 8 subscribers from the British Empire, 2 subscribers in Hawaii and 38 biological libraries, public libraries, and hospital libraries in the United States. Included in the subscriptions were 36 Canadian, 8 Australian, 12 English, 1 from the Union of South Africa, and 1 from New Zealand.

VI. COST OF THE PROGRAM

Gross subscription income to the Office of Alien Property Custodian has totaled $311,292.92. Printing costs have totaled somewhat less than this amount. No definite allocation of general overhead costs has been made to the program, but it is clear upon review of total direct and indirect expenses that the subscription income has been sufficient to retire all costs of the program to the Office of Alien Property Custodian.

VII. REPRODUCTION OF BOOKS

No report concerning reproduction of scientific materials originating in enemy countries after 1941 would be complete without reference to books as well as journals. Scientific books published in Germany in 1941, 1942, 1943, and 1944 were surreptitiously obtained by the Office of Strategic Services. Reproduction of the books was licensed to commercial publishers on a basis calculated to encourage the most extensive publication and dissemination. Nearly 700 works were licensed for republication. The books concerned subjects of direct interest to those engaged in war activities, including analysis of gases, analysis of metals, atomic fission, ballistics, electric amplifiers, electrolytes, electron emission, food analysis, magnesium, magnetic measurement, optics, organic chemistry, sound waves and measurement, synthetics and many others. A list of all books licensed, including those of recent date, is attached as an exhibit. It is noted that the prices charged are substantially less than prewar prices. For example, volumes of Beilstein's Handbuch der Organischen Chemie, which would normally have sold for $60 before the war, are currently sold for $12. The books were sold principally to industrial concerns, government agencies and research institutions throughout almost all the allied nations.

VIII. ASSISTANCE

The Office of Alien Property Custodian was fortunate in obtaining substantial support and assistance in the program from outside sources. The original copies of journals were obtained for the Custodian by the Interdepartmental Committee for the Acquisition of Foreign Publications, which operated under the general direction of the Office of Strategic Services. The story of how original material was obtained is yet to be told, it is, of course, obvious that the program could not have succeeded except for the aggressive and competent efforts of representatives of the Interdepartmental Committee in obtaining original copies of journals from Europe throughout the war. Columbia University made its facilities and personnel freely available for use in the project, and particularly effective assistance was rendered to the program by Dr. Luther H. Evans, now Librarian of Congress.

The CHAIRMAN. Thank you very much, Mr. Sargeant.

Mr. Ooms, the Commissioner of Patents, is the next witness.

TESTIMONY OF CASPER W. OOMS, COMMISSIONER OF PATENTS

Mr. OOMS. Mr. Chairman, I have a very brief statement which will take only a few minutes to read, but I don't object to questioning at any point and if you want me to elaborate at any stage of the hearing I should be happy to give you what help I can.

I am pleased to have this opportunity to appear before this joint committee and to make this statement upon the three bills upon which these hearing are being held. I do not think I can be of any substantial help to the committee on the broad questions upon which the distinguished witnesses who have appeared here have been heard. There appears to be no dissent to the general objectives of this legislation, and I claim no special experience that would enable me to assist the committee on the question of the precise form of organization of the National Research Foundation. I have read much of the testimony that has been presented here, and to the extent that my opinion on these questions may be of use, I can say that I am in full accord with the statement made here by the Secretary of Commerce.

If I can be of any help to this committee, it may be upon an issue that has been frequently debated here, that revolving about the so-called patent provisions of this legislation. All of my professional life has been spent in the field of patent law, first as a law clerk to a bench of appellate court judges, then as an active patent lawyer, and only briefly as Commissioner of Patents.

The Magnuson bill (S. 1285) has no express provisions on patents. Section 7 (d), empowering the foundation to deal with property of all kinds needed in the project or resulting from its activities doubtless confers the broadest possible powers upon the foundation to patent the inventions resulting from its research and to handle any resulting patents as any other organization might. I do find an implied exception to that broad power in section 7 (f), wherein the foundation is specifically authorized—

to publish or arrange for the publication of scientific and technical information so as to further the full dissemination of information of scientific value consistent with the national interest * * *.

The only purpose for this dissemination of the scientific information yielded by the work of the foundation is to permit its utilization in

the national interest. I do not think that the section contemplates that the disclosure shall be made by patenting, which not only involves a substantial time lag in the publication, but necessarily involves the prohibitions against use without license that are found in the patent grant.

The Kilgore bill (S. 1297) contained, in section 302 (b), a similar authorization and direction:

> to collect, edit, publish, and disseminate pertinent data on all inventions and discoveries and other findings resulting from federally financed research and development activities,

and in section 303, the mandate to—

> promote a widespread distribution of information which may be useful in research and development activities

and to take steps—

> to make such information accessible to the public, * * *

From these provisions I would read the same implication, that the statute contemplated publication by other means than patenting, except for the express provisions in section 305 (a) to (c) inclusive formulating a patent program for the foundation. This program required the director of the foundation to "patent all significant inventions or discoveries resulting from" the research and development activities of the foundation, and to issue free nonexclusive licenses under such patents. The act contained further provisions against licensing any applicant when the Department of Justice found that such license might—

> tend to promote or result in a monopoly or a practice which is in restraint of trade within the purview of the Sherman Act.

The final provision of that section 305 placed the responsibility for the legal work arising with relation to patents and patent litigation in the Department of Justice, and also imposed upon the Department the duty, upon request, to intervene in litigation brought against any licensee growing out of the issuance of the license.

I have never been able to understand why the administrative burden of this patent program would be imposed upon the foundation, for obviously the only purpose which the patents procured by the foundation could serve would be as a policing device to prevent the use of the foundation's published research in an enterprise that might tend to promote violations of the antitrust laws. The administrative burden would be onerously increased by the provision with respect to participating in patent litigation on behalf of holders of the free nonexclusive licenses issued under the act.

The purposes of the patent law, "to promote the progress of science and useful arts," by the grant of exclusive rights to practice inventions, do not contemplate the type of wholesome national enterprise which is created by this legislation. The patent grant was designed to serve as an incentive to invention, and its restrictive powers of exclusion, which are granted as an exception to the common-law intolerance of monopoly, are granted only as a necessary means to provide the incentive. There are byproducts of this process that are important in our economy. The holder of the exclusive right under the patent is protected in his solitary exploitation of his invention through the common period of difficulty through which most inventions pass when

they are placed into commercial production. Investors in the enterprises are given some measure of protection against having their promotional expense and effort appropriated by competitors who have not shared this expense and effort.

None of these considerations apply to the research and inventive work entrusted to the foundation. The incentive exists in the will of the Government to have the work done, and the Government undertakes all the of risks of success and failure. Only the people for whom the Government acts share in the resultant benefits, if the project is successful, or bear its cost if the project fails.

In the absence of the considerations besetting the inventor, which the authors of the Constitution recognized as justifying the creation of the exclusive rights conferred by patents, there does not seem to be—in the absence of other paramount considerations—any need for patenting the inventions of the staff of the foundation.

The objectives of the foundation, recited in both acts, are to assure the widest possible use of the scientific knowledge yielded by the enterprise. Patenting would restrict this use. Any licensing plan, with its necessary technicalities, would discourage it. And certainly the patenting program was not devised merely to provide a device by which some antitrust policing could be done by the Department of Justice.

The CHAIRMAN. Under your theory, then, no patents should be sought at all?

Mr. OOMS. That is with the exception, Mr. Chairman, of those exceptional cases that are related in the further sections of the current draft of the bill, which provides for an escape clause where there are peculiar facilities that are available only if you do make some such provision. For the general work of the foundation I think patenting would be a mistake.

The CHAIRMAN. Then what is to protect the public from somebody's taking the results of the research and limiting its production in such a way by an exclusive monopoly on it?

Mr. OOMS. How could they? Upon publication of the work, if the foundation is responsible——

The CHAIRMAN (interposing). Yes, but publication takes some time.

Mr. OOMS. I think we can move pretty rapidly on that. It doesn't take as much time as patenting does.

The CHAIRMAN. It takes more time than filing an application does.

Mr. OOMS. I don't think so. You can run over here to the Superintendent of Documents' office and put something through overnight if you want to.

I am not afraid of that lag in publication, and even if the publication isn't there, the patent can only be granted to the first inventor, and if we set up an appropriate procedure in the Patent Office we can certainly prevent any man who appropriates that work from getting a patent by fraud.

The CHAIRMAN. You are talking about Patent Office reforms.

Mr. OOMS. No, not yet.

The CHAIRMAN. I am talking about provisions. We are still back in the beautiful idealistic age, as far as the public is concerned, that caused the inception of the patent law, are we not?

Mr. OOMS. Yes.

The CHAIRMAN. But you know we have gotten about 5,000 miles beyond that idealistic age in the operation of the patent law.

Mr. OOMS. The inertia of the human being or any social system is very great.

The CHAIRMAN. No, the failure of the American public to understand the abuses that can grow up from it.

Mr. OOMS. I agree with you, Senator.

The CHAIRMAN. It has gotten so that the inventor himself very seldom gets the full use and benefit of his invention, isn't that right? Usually it is purchased by other people for promotion purposes, sometimes by their contract with him.

Mr. OOMS. I wouldn't say usually, Mr. Chairman. One of the difficulties we have with all of these patent problems is, we are talking without any real data. You have produced some in your various hearings; Senator Bone had some hearings a few years ago; there are some documented cases in the Department of Justice; but the great mass of industrial activities under patents is wholly unexplored. There has been no effort made to survey that, and sometime we should survey that, we should find out how our patent system works in the normal situation.

The CHAIRMAN. You remember what happened to Senator Bone?

Mr. OOMS. He went on the bench.

The CHAIRMAN. He hit the patent pool bunch and he retired to the Senate Chamber from his hearings because they blocked further hearings in which he wanted to explore that. One of the greatest disappointments of his life was that he couldn't make a full, detailed exploration of that patent situation because of pressure groups. If you will read his reports, you will find they are cut off right in midair.

I have very close personal knowledge of those hearings.

Mr. OOMS. I don't know except that I have read the reports—and they are very good reports—and I have read the hearings. I would say if the Senate of the United States wanted to make a thorough survey of the whole question of patent utilization in the United States, it could be done. It would be a big job and very expensive, but probably it should be done at some time.

The CHAIRMAN. Don't you think it ought to be done?

Mr. OOMS. Oh, I have been urging it. I talked to Dr. Bush about it. I notice he mentioned it in these hearings, and I have talked to everybody who would listen to me.

The CHAIRMAN. It is just like Mark Twain said about the weather—"nobody ever does anything about it." As a result the abuses keep on growing. What I am after, and I am serious about this——

Mr. OOMS. I am, too, Senator.

The CHAIRMAN. Is that I want an operating system that will prevent the exploitation of Government funds. I realize, as you must realize, that the major portion of this research would be unpatentable.

Mr. OOMS. That is true.

The CHAIRMAN. However, results of a similar nature have been patented in the United States Patent Office in the past. If you don't believe that, read the vitamin suits, the records of utterly unpatentable basic research, done by a couple of Agriculture Department engineers who patented it, and the public was milked to the tune of $8,000,000 in 4 or 5 years; and then finally it did get to the Supreme Court and this

alleged patent which had been granted was thrown out. Had there been some method of filing with the Patent Office the results of that research, on the part of the public, nobody could have filed a patent on it if it was unpatentable.

Mr. Ooms. I made that suggestion some 2 months ago in a speech in New York.

The Chairman. I think one of the greatest things you have done at the Patent Office during this war is the filing of secret applications. It did only one thing: It set a definite date line for the completion of a piece of research ending in an invention, so that somebody whose date line was later than that couldn't come in afterwards and leapfrog back over it and say, well, here, this fellow has stolen my work. I think that was one of the greatest steps forward you took. It gave the Office a record.

Mr. Ooms. Do you think we need as elaborate a procedure as we have for that purpose, or can't we set up a real office of record that doesn't necessarily culminate in patenting?

The Chairman. Certainly, but it seems to me the patent lawyers should look to that.

Mr. Ooms. We have a lot of things to look to, from what I have heard in the last 2 weeks in these hearings.

The Chairman. Yes, I think so.

Will you go ahead with your statement?

Mr. Ooms. In the working draft of S. 1297, dated October 8, these provisions have been omitted. In place of them section 7 (c) contains a sweeping provision for the free dedication to the public of all findings and inventions "produced in the course of federally financed research or development," with an exception in section 7 (d) for different treatment to protect the contractor who had made substantial developments in a project without the aid of federal funds.

With the principles of these provisions I am in complete accord. I do not believe, however, that the escape clause found in section 7 (d) is entirely adequate to accomplish its purpose. The need for some flexibility will arise when some contractor has done substantial work at his own expense at a time when the foundation finds it urgent to expedite that project. Economy of effort and of time dictate that the work shall be entrusted to that contractor, but he would be penalized heavily were he to be required thereby to sacrifice his title to his own development. I do not think that such a contractor would feel that his interest were protected by the present formulation of the escape clause, by which the contractor gets little more than a right of appeal. The foundation should be empowered to formulate the terms of that exceptional contract in advance, before any of the foundation's funds have been spent. The provision as now drawn would, I fear, deprive the foundation of access to an exceptional, but occasionally very necessary, contractor. A modification of the language of the bill, such as I have suggested, to permit the advance formulation of exceptions to the general rule of public dedication of patents, can very easily be prepared. With this modification, the patent provisions of the working draft are clearly in the public interest and should be adopted.

The Chairman. I wonder if you would care, not now but later, when you have studied it over, to furnish the committee with suggested language from your experience for a better escape clause there, one that is more workable.

Mr. Ooms. I will be happy to, Mr Chairman.

Many of the witnesses who have appeared here have opposed this provision as patent legislation beyond the true scope of this bill. I do not agree that this is patent legislation. It in no way affects or alters the patent law or its administration. It merely expresses the national policy with respect to patents procured upon inventions made at the public expense. It is time that such a policy is formulated and declared. I need not remind this committee, and especially not its chairman, of the infinite variety of patent policies that are now being followed by the many bureaus and departments of the Federal Government. Literally, hundreds of books have been published on the subject. It has been debated for more than 40 years. It is impossible to find any resemblance to uniformity in the practices of the several bureaus even within a single Government department. I see nothing difficult or impossible in expressing that policy in this bill, assuming that there is sufficient flexibility provided to care for the exceptional situation.

The argument has often been made that unless employees of a bureau—or I would add their contractors—are permitted to retain some part of the rights to inventions produced by them while in the Government service, employees of necessary competency cannot be procured at the salaries the Government is ready to pay. I am not persuaded that that is true. If it is, there is a defect in the personnel policy of the Government that can better be remedied by adjustment of compensation, than by enticing men into the service with the suggestion that the service is a lottery with big stakes to the man who produces an invention that can be exploited outside of the Government service.

It is unfair to men in the service, as those working on profound fundamental problems that seldom yield readily utilizable inventions would be prejudiced as compared to those working nearer the fringe of industrial applications, although the latter may frequently be engaged upon less important and less difficult problems. There would also be a conflict of interests between the goals of the foundation and the personal interests of the employees were they offered any opportunity to divert their energies to work that might yield inventions which they could exploit.

We have in the Patent Office hundreds of competent men, trained and working in scientific fields. They are forbidden by law to acquire interests in patents except by bequest or inheritance. Their devotion to their work is no less because of this restriction upon their right to acquire property, and you may be assured that they are confronted with the same rather low compensation scale that prevails in many Government bureaus.

I turn now to a different phase of this legislation, that covered by section 8 (b) of the working draft of October 8. Briefly, that provision is designed to further a purpose expressed in section 2 (f) of the Magnuson bill, "to foster the interchange of scientific information among scientists in this country and abroad"; and in the recital found in section 2 (g) of the working draft:

(g) To cooperate with other nations in the support and encouragement of scientific research and development and in the application of the results of such research and development for the furtherance of international security and welfare.

It may be asked how a provision with respect to patenting can advance the interchange of scientific information. It sounds paradoxical. This is the situation: Following our policy of free publication in this country we provide immediate access by all countries to this material. We offer no inducements to those countries which might be selfishly disposed to reciprocate. Under our liberal international arrangements for filing patent applications abroad, other governments could well patent their developments in this country and make their contributions available only at a price. We would like to encourage a free interchange.

The CHAIRMAN. You mean that we adopt the same policy with regard to all countries, regardless of their policy toward us with regard to patents; is that right?

Mr. OOMS. We do at this time; we have an international convention to which most countries are parties, but we do have some exceptional situations in Russia and China, for example, where today there is practically no interchange. It is a matter that should, of course, be looked into if we are going to have a real interchange of scientific data.

The CHAIRMAN. There is no real standardization of patent laws as between countries so that a patent in this country operates under a similar law to a patent in England. We have free interchange and an American inventor going over there is not sure as to what law he operates under in foreign countries although we do have an interchange.

Mr. OOMS. That is correct.

The CHAIRMAN. Don't you think it would be advantageous to inventors if we could have a uniform patent law throughout the world so that provisions in every nation would be the same?

Mr. OOMS. I think it would be, but I am afraid each nation would think its own is probably the best.

The CHAIRMAN. I realize that, but I am talking about advantage to the people of the world.

Mr. OOMS. I think it would be.

The CHAIRMAN. And to the inventors and research people.

Mr. OOMS. I think it definitely would be. You would have to amplify a lot of things. You might even make it effective so that patenting in one of the convention countries, assuming such a convention as the chairman has suggested, would affect patenting throughout the world. If you had that situation, you would have a much more comprehensive method of searching than we now have. You would have to do a lot of things but it would be a definite improvement.

We have a substantial consideration to offer each country, in that we relinquish all patent rights in any foreign country that will do the same here, and if our history informs us properly we shall contribute as much and possibly far more than any other country to this common pool. We must, however, to advance this trading, be in position to patent the foundation's inventions wherever we are unable to persuade the foreign country of the wisdom of the free interchange.

I pass now briefly to the Fulbright bill (S. 1248). I don't know, Mr. Chairman, whether you want me to discuss that or just file it.

The CHAIRMAN. I wish you would file that because we have agreed to have a later hearing on the Fulbright bill, inasmuch as it is somewhat on a different line. The Secretary of Commerce and other officials want to testify on it specifically, separated from the other bills.

Mr. Ooms. I shall be happy to come back on this.

(The remainder of Mr. Ooms' statement, which was filed, follows):

I support the principles of S. 1248. We have an elaborate patent system designed to create incentives to people to invent. The completion of the invention, and the granting of the patent, are but preliminary steps to the utilization of the invention, which is the final object of the patent system. We hold out the patent as an incentive to the inventor, but we lose all interest in him when he has his patent. He frequently has no idea of how to exploit his invention or how to reach those who might exploit it for him.

Under the terms of the Patent Act, the Commissioner must find an invention "sufficiently useful and important" before he issues the patent. If the invention is "sufficiently useful and important" to warrant the granting of the patent, it certainly justifies some slight additional effort to see that practical steps are taken toward its utilization. We are taking some of those steps at the Patent Office in publishing a register of patents available for licensing or sale. The Patent Office is limited, however, in the measures which it may take to facilitate the more rapid and extensive use of new processes and products in industry. It is a quasi-judicial agency, and therefore could not properly undertake the promotion and development work contemplated in this bill. I firmly believe that adequate means should be provided elsewhere in the Department of Commerce, as Senator Fulbright has suggested, to make patented inventions more useful and more generally available. I endorse the objectives of the bill to give Government encouragement and assistance to the introduction of new techniques which will result in public benefits, to help the inventor secure the rewards of his ingenuity, and to give all business, and especially small business, earlier and more equal access to new technological developments.

I am somewhat troubled by the administrative problems created by section 5 of the bill. As now written, the provisions of that section read with section 3 (b) would place almost any suggested invention within the purview of activity of the new Bureau established by the bill, and I feel certain that the author did not intend the functions of the Bureau to be so comprehensive. There are a larger number of inventions, which, while practical, are wholly trivial in their economic significance. The complexity and cost of an organization that would undertake to evaluate and offer assistance on all of these might prove excessive as against the contribution which such a facility might make to the national economy. There are other provisions in the bill which I think require some further consideration, and if the committee desired further work upon it I shall be glad to return at the committee's pleasure with more specific comment.

(Additional material submitted by Commissioner Ooms:)

OCTOBER 17, 1945.

Hon. HARLEY M. KILGORE,
United States Senate, Washington, D. C.

MY DEAR SENATOR: I feel certain you will be interested in the Public Register of Patents Available for Licensing or Sale, a service rendered to inventors, patent owners, manufacturers, and industry. The enclosed circular describes the philosophy back of its establishment as well as the simple procedures involved in registering a patent or securing information about such a patent.

Statistics are burdensome and usually require more statistics in explanation, so in lieu of such data permit me to say that this service has met most favorable response from inventors, manufacturers, and the press. Many veterans, both in and out of the armed forces, have shown a deep interest in the register and have stated their desire to secure items for manufacture. Small business owners and managers advise us of their facilities, the type of labor available, and other pertinent facts, and request suggestions as to material available from the register for their use.

The register is the only impartial central point providing an opportunity for the inventor or patent owner to make known his willingness to have his patent put to use, and industry to know what is available that may aid in keeping plant facilities and employees fully occupied.

Very truly yours,

CASPER W. OOMS,
Commissioner of Patents.

General Information Concerning the Public Register of Patents Available for Licensing or Sale

The following material has been prepared for the information of those who may be interested in the objectives and operation of the register of patents available for licensing.

1. *Purpose of the register.*—It is believed that many owners of unexpired patents covering inventions not now in commercial use would be glad to grant licenses under their patents to prospective manufacturers on reasonable terms but have not done so for lack of means to contact and interest manufacturers in the exploitation of their inventions. It is also believed that in the immediate postwar era many manufacturers will be searching for new devices and products suitable for manufacture with their various facilities. It is the objective of the register to assist in establishing contacts between such patent owners and manufacturers.

2. *Who may register.*—Anyone who has a right to grant licenses under a patent can submit the patent for entry on the register.

3. *Fees.*—There is no fee charged for this service.

4. *The registrant's obligation.*—There is no legal obligation. However, it will be assumed that the patent owner is acting in good faith in presenting his patent for entry on the register and that he will obligate himself to grant licenses under his patent on stated or reasonable terms.

5. *Government benefits from this service.*—The Government derives no benefit from this service other than that which accrues from the welfare of its citizens. This is a free service rendered by the Government for the purpose of fostering wider employment and a quicker utilization of new developments.

6. *Assurance of results.*—There is no assurance by the Patent Office that the placing of a patent on the register will result in applications for licenses under the patent.

7. *Duration of registration.*—A patent will remain on the register for the remainder of the life of the patent unless withdrawn by the owner or deleted upon evidence of lack of good faith on his part.

8. *Withdrawal of patent from the register by the owner.*—A patent on the register may be withdrawn by the owner at any time.

9. *Publicizing the availability of patents for licensing.*—Entry of a patent upon the register of patents available for licensing will be published in the Official Gazette of the Patent Office. Periodic list of patents classified according to subject matter will be sent to trade publications dealing with the various kinds of subject matter for publication. Manufacturers making inquiry of the Patent Office for assistance in finding new products for manufacture will be furnished with lists of patents on the register relating to the subject matter in which they are interested. Inquiries by manufacturers with respect to specific patents on the register will be referred to the patent owners.

10. *Statement of terms at time of entry on the register.*—The patent owner must when he requests entry of his patent on the register state that he will assign his patent or grant licenses on reasonable terms. The specific terms need not be stated although they may be stated if the patent owner so desires.

11. *The patent owner's discretion in the choice of licensees.*—The matter of the party or parties to whom licenses are granted is entirely within the discretion of the patent owner.

12. *The Patent Office is not responsible for prospective licensees.*—A patent owner should determine whether a prospective licensee is reputable by the usual methods any prudent individual would observe, such as credit reports, business ratings, etc. The Patent Office assumes no responsibility for prospective licensees.

13. *Exclusive licenses.*—Entry of a patent on the register does not preclude assignment or exclusive licensing.

14. *Ownership requirement.*—Ownership of record is a condition precedent to entry of a patent on the register.

15. *Assistance to patent owners in license negotiations.*—The Patent Office cannot assist the owner of a registered patent in his negotiations with a prospective licensee in matters such as fixing of terms, drawing a contract, etc. The responsibility of the Patent Office ceases with the establishment and maintenance of the register.

16. *Evaluation of commercial possibilities.*—The Patent Office will make no comment as to the relative merits of similar items disclosed in patents that have been placed on the register or evaluate in any way the commercial possibilities of such patented items.

17. *Procedure in entering a patent on the register.*—The patent owner must file a written request for registration stating that he has a right to grant licenses under the patent, citing the place where proof must be recorded. He must state that he obligates himself to grant licenses on stated or reasonable terms. The request for registration must be accompanied by a soft copy of the patent or an order for a soft copy.

The CHAIRMAN. Thanks very much, Mr. Ooms.

We have two panels from the Engineering College Research Association and the engineering societies. Dean MacQuigg, you can begin. If you want to comment extemporaneously and file a prepared statement, you may; or you can read a prepared statement, whichever you want to do.

TESTIMONY OF C. E. MacQUIGG, DEAN OF ENGINEERING, OHIO STATE UNIVERSITY, ENGINEERING COLLEGE RESEARCH ASSOCIATION

Dean MACQUIGG. I am Charles Ellison MacQuigg, dean of engineering and director of the engineering experiment station at the Ohio State University in Columbus. I am a member of the Engineering College Research Association, am vice chairman of the Ohio Water Board, and have had some twenty-odd years' experience in industry.

The CHAIRMAN. Before we go ahead, let us identify the other members of the panel.

(The other members of the panel were presented.)

THORNDIKE SAVILLE, DEAN OF ENGINEERING, NEW YORK UNIVERSITY AND H. P. HAMMOND, DEAN OF ENGINEERING, PENNSYLVANIA STATE COLLEGE

Dean MACQUIGG. The association comprises 67 of the principal engineering colleges of the country engaged in substantial research programs. These institutions are equipped with many millions of dollars worth of research facilities, and have among their staffs several thousand experienced research engineers and scientists.

The association is unique among the many educational associations of the country in that it is believed to be the only group of institutions of higher education devoted solely to the promotion of engineering and scientific research, including the training of research workers. The constitution of the association provides, among other things, that the association shall "cooperate with war agencies of the Government in the prosecution and promotion of research," and that it shall cooperate "with Government agencies concerned with research in the interest of the maximum utilization and development of the engineering and scientific activities of the Nation." It is therefore natural that the association should be gravely concerned with the conditions surrounding the establishment of a national science or research foundation.

May I point out there also, Senator, that this is sort of an old story with this group and their predecessors. I don't know, I can't give you a specific reference, but certainly as early as the Sixty-fourth Congress, the first session, Senator Newlands had a bill along this

same general line, and that was very actively backed by many of these institutions that are represented in this present association.

The Engineering College Research Association joins in hearty support of the proposal to establish the proposed National Research Foundation. Grounds for this support have been stated amply and well in testimony previously offered in the present series of hearings and need not be repeated. Our association believes, however, that in the interest of accomplishing the purposes of the foundation changes should be made in the legislation proposed for its establishment. We do not appear in favor of either of the two bills, S. 1285 or S. 1297, as opposed to the other, but in the interests of brevity and ease of revision we address our remarks to S. 1285 as amended October 12, 1945. We desire also to emphasize certain points of view which, as the result of long experience in basic engineering and scientific research, we consider fundamental to the accomplishment of the objectives of the proposed legislation and in the national interest. We therefore offer the following proposals:

(1) We believe that in the interest of military preparedness and industrial supremacy basic engineering research cannot and should not be dissociated from fundamental scientific research. The idea that the two should be associated in the proposed legislation has received support in testimony before your committee, but the term "engineering" does not thus far appear in either of the bills before you. If this omission is continued in the bill finally adopted it will constitute, in our opinion, a serious defect. We do not advocate Federal support of applied or industrial research, but we believe that basic research in such fields as aerodynamics, thermodynamics, hydrodynamics, electronics, and the characteristics and behavior of water and sewage—all subjects universally dealt with in advanced engineering instruction and research—should be included within the scope and purposes of the proposed foundation.

To insure the support of basic engineering research, we propose that section 5 (a) 2 be reinstated in S. 1285, and read as follows: "A Division of Physical Sciences, including basic engineering; programs relating to research in the mathematical and physical sciences." In any case, and to make the meaning clear, we propose that the term "physical sciences" be followed by the phrase "including engineering."

We recommend further that section 5 (a) of S. 1297, as amended October 8, 1945, be substituted for section 4 of the original version of S. 1285, except that the term "postgraduate" be inserted before the term "scholarship."

We also recommend that section 7 (i) of S. 1285 be amended by inserting a comma in line 5 after the word "science" and inserting the word "engineering" followed by a comma.

(2) With respect to the type of organization to administer the act, we recommend that a board of nine members be appointed by the President upon nomination of one or two persons from each of the several competent national scientific and engineering organizations such as the American Medical Association, American Association for Advancement of Science, Engineers Joint Council, National Academy of Sciences; and so forth, and so forth. We believe that all administrative details should be placed in the hands of director, nominated

by the board and appointed by the President from three or more names submitted to him by the board. The director should be responsible to the board in all matters of general policy, but should have a free hand in the details of administration; such a plan seems adequately justified in almost all kinds of human activity. We believe that not more than four of the board of nine appointed by the President should be full-time Government employees, including military personnel. Board members should be entitled to travel expenses and $50 per diem in order to make possible the membership of younger men who otherwise might be financially embarrassed by demands on their time. A top annual limit of say $1,000 total per diem should be stipulated.

We recommend, therefore, that section 3 (b) of S. 1285 be amended by adding the sentence "Not more than four members of the board shall be full-time Government employees, including military personnel"; that section 3 (e) be amended to read as follows: "The members of the board shall be allowed a per diem allotment of $50, not to exceed a total of $1,000 per year per member, plus actual and necessary traveling and subsistence expenses when engaged in the duties of their office"; and that section 6 (a) be amended by striking in line 18 the words "National Academy of Sciences" and substituting therefore "recognized national scientific and engineering organizations."

(3) Our committee feels that the Congress should and probably will authorize generous appropriations to the military services to continue research activities. Moreover medical research has been and is likely to continue to be liberally supported by private and Government funds outside of the provisions of the bills under consideration. Hence, our committee suggests that in section 8 (a) of S. 1285, in lines 16, 17, and 19, the words "at least" be changed to read "not more than."

(4) By no means deprecating the importance of the social sciences, we believe that they merit separate support for research and should not be included in the present proposal. In view of the importance of the social sciences we believe that our association will support a separate bill to that end. Such separation would be of greater overall good to the public; in other words, the two fields of physical and social science do not belong together in the scope of the agency it is proposed to set up.

(5) We should emphasize especially that in the interest of freedom of action which is essential to the successful prosecution of research enterprise in nonprofit institutions subsections (b), (c), (d), and (h) of section 7, of S. 1285, as amended, be included in any legislation to be enacted.

The Chairman. Before we have any questions, I will ask Dr. Bakhmeteff to present his statement.

TESTIMONY OF DR. BORIS A. BAKHMETEFF, COMMITTEE FROM THE FIVE MAJOR NATIONAL ENGINEERING SOCIETIES

Dr. Bakhmeteff. I am acting here, Mr. Chairman, as spokesman for a panel of five from the five major national engineering societies.

The Chairman. Let us identify the other members of the panel.

J. H. RUSHTON, PROFESSOR OF CHEMICAL ENGINEERING, UNIVERSITY OF VIRGINIA

Dr. BAKHMETEFF. This is Dr. Rushton, who represents the chemical engineers, and is a member of the American Institute of Chemical Engineers. He is the head of the department of chemical engineering at the University of Virginia, and I understand he has been head of one of the sections under Dr. Bush's work.

F. MALCOLM FARMER, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Dr. BAKHMETEFF. The next member of the panel is Mr. F. Malcolm Farmer. He is a fellow and past president of the American Institute of Electrical Engineers. He is vice president of the Electrical Testing Laboratories in New York.

A. G. CHRISTIE, SOCIETY OF MECHANICAL ENGINEERS

Dr. BAKHMETEFF. The next witness is Prof. A. G. Christie, past president of the Society of Mechanical Engineers. He is professor at Johns Hopkins University in Baltimore, and is a prominent consulting engineer.

ROBERT H. MORRIS, DIRECTOR, INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

Dr. BAKHMETEFF. This is Mr. Robert H. Morris. He is a member of the board of directors of the Institute of Mining and Metallurgical Engineers, and is vice president of the Gauley Mountain Coal Co. I believe he comes from West Virginia, Senator Kilgore.

These members of the panel are not the men who signed the statement because substitutes were appointed in view of the change of time.

I want to state that this panel has been appointed by action of the Engineers Joint Council, a body which represents all the head executives of these five societies and an aggregate membership of 75,000 qualified engineers, so we think that we represent pretty well the societies as a whole.

With your permission, I am not going to read the statement. We have here a very carefully prepared statement, rather concise, and I would like this to be made a part of the record.

The CHAIRMAN. It will be made a part of the record.

(The statement of the Engineers Joint Council, which was made a part of the record, follows:)

This statement is submitted on behalf of a special panel of appointees from the five major national engineering societies, viz:

The American Society of Civil Engineers.
The American Institute of Mining and Metallurgical Engineers.
The American Society of Mechanical Engineers.
The American Institute of Electrical Engineers.
The American Institute of Chemical Engineers.

The panel was appointed by action of the Engineers Joint Council, a body composed of the head executives of the aforesaid societies, the aggregate membership of which approaches 75,000 qualified American engineers. The Engineers Joint

Council, at whose behest the panel presents its views, constitutes thus the crowning body of the organized American engineering profession as a whole.

Engineers are vitally interested in basic scientific research, for such research is the foundation of modern engineering. In fact, the position and role of the engineer in the human community is that of an active link between basic scientific research and technology. It is the engineer who makes use of the fruit of scientific progress and turns it to the practical service of man. Applied research is actually planned and carried out by the engineer. That is his recognized field. However, the engineer is directly concerned with, and actively engaged in, basic scientific research. Indeed, recent progress of technology has grown out of an unprecedented development of engineering science, meaning a fundamental knowledge of the laws of nature which permit the mastery of the resources and powers of nature. The significance of engineering science in present society is best illustrated by the example of Germany, which was the first country to recognize the vital importance of basic engineering research. The result was the miraculous technical achievement of which the world has been the recent witness, and of which humanity came so near becoming a victim.

In many ways the practicing engineer bears the same relationship to fundamental research in the science of engineering as does the practicing physician to the basic investigations of the scholarly doctor in the medical and biological fields. The practicing engineer applies the basic principles discovered by engineering science to technological problems, just as the practicing physician uses scientific discoveries for healing the sick.

In presenting the viewpoint of the engineering profession, which may rightfully consider itself as particularly expert in appraising the value and portent of scientific research, the undersigned panel unreservedly endorses the broad objects of the proposed legislation in regard to basic scientific research. The engineering profession stands undivided back of the words of the President, that "Progress in scientific research and development is an indispensable condition to the future welfare and security of the Nation."

Furthermore the circumstances under which this country is facing the problem of promoting basic scientific research, are unprecedented and are marked by pressing urgency. By the force of events growing out of the war, the United States has been thrust into a position of prominent leadership in world affairs. It is incumbent on us to continue to preserve and maintain this leading part from this time forward. We must be prepared for any military eventuality. War has become a battle of scientists. Also this country must lead in science to assure national health, prosperity and welfare. As the President stated: "No nation can maintain a position of leadership in the world of today, unless it develops to the full its scientific and technological resources."

The American people have been foremost in technical ingenuity and industrial organization, and in research of "applied" character. It is a well-acknowledged fact, on the other hand, that in the realm of basic sciences and basic scientific research the United States did not keep pace with the principal nations of the Old World. Indeed, to a large extent, practical applied research in the United States relied on basic scientific material coming from overseas. The war has violently upset this balance. Europe is in eclipse. For years to come, in the intellectual and scientific realm the United States will have to depend on its own resources. This brings this country face to face with a problem of utmost gravity. Under the threat of losing its primacy, the United States "must" speedily fill the void left open by the ravages of Europe, and within the shortest allowable period bring up its own scientific research to a level which, in scope and quality, will measure up to the requirements of this country's New World position.

It is self-evident that the size and the urgency of the problem are such that scientific research in this country no longer can be allowed to depend on the course of natural development that prevailed in the past, and to rely upon the diminishing funds of private philanthropy. A systematic and generous yearly appropriation of Government funds becomes a necessity. Under such circumstances the engineering pool joins its voice to the universally endorsed proposal of a special national foundation for promoting and developing basic scientific research.

The situation indeed bears a resemblance to that at the beginning of the war, when the country was called upon to build overnight a war industry capable of meeting the most formidable threat of all time. However the conversion of our peacetime industry to war was largely a problem of material reorganization, while the present problem of bringing to life and stimulating creative, scientific endeavor

largely lies in the spiritual and intellectual realm. Indeed, the delicacy of the problem requires the most careful and considerate approach. Methods must be chosen which would assure an optimum and most speedy development. It is equally imperative to abstain from measures which could impair or stultify the sought-for objective.

In formulating the following opinions, the undersigned engineering panel is motivated by the desire to find the best possible solution for a problem of highest national importance:

a. The primary purpose of the proposed foundation should be basic scientific research. It is in this realm that the United States has been lagging behind. As a general principle, the foundation should not spend Government funds for research in fields which have been obtaining, and will continue to obtain, financial support from other sources. Accordingly there is no need for the foundation to support "applied" research. Indeed, experience has shown that adequate funds and means were readily found in the past for research of applied practical character. Also there are many research men and organizations, in the field of technology and applied sciences, that are well supported by industry and partly by special public agencies for the purpose of developing new products and processes for business concerns of all sizes.

Federal aid, on the other hand, is sorely needed and should be generously provided to enhance and support basic scientific research. The latter obviously is the foundation for practical applied advancement. But basic research in itself bears the distinction of being undertaken without any immediate idea of profit. The results are to be of service to humanity at large.

b. It is the view of this panel that basic research necessarily implies fundamental research in the engineering sciences. Although none of the proposed legislative proposals has so far deigned to mention engineering research by name, we feel that it is unnecessary as well as impractical to enumerate the different ramifications of science in the proposed legislative act. Research in the sciences should mean that the foundation will promote basic scientific work on all possible lines, recognizing fundamental engineering research as one of its major objectives.

c. In the opinion of this panel no useful purpose will be served by extending the scope of the foundation to embrace "social sciences." The engineers in their wide contacts with "men," keenly appreciate the value and significance of better social understanding. The character of the problems, however, is essentially distinct from those dealing with the physical world. Social studies should be the object of a separate agency composed of an altogether different type of man. Placing social sciences under the same roof with natural sciences will help neither and impede both.

d. In discerning the ways and means by which optimum progress in basic scientific research can be achieved, the undersigned panel wholeheartedly ranges itself back of the words of the President, that:

"Science can be coordinated and encouraged, it cannot be dictated to or regimented. Science cannot progress unless founded on the free intelligence of the scientist * * * the Federal Research Agency * * * should in no way impede that freedom."

In deciding upon the preferred form of organization and on the modes of functioning of the foundation, this panel is guided by the conviction that progress in science is essentially a matter of free and uninhibited display of creative scientific endeavor. Accordingly, any plan intended to call to life and promote basic scientific research must devolve from the aim of providing a propitious atmosphere, in which creative human talent will assert itself to supreme advantage. Reduced to practice, the problem is to select scientists endowed with creative capacity and to place them in an environment where, with proper material support, scientific talent will thrive and bear fruit.

With regard to the form of organization, the essential feature is to place the foundation in the hands of men competent and experienced in scientific research and removed from all possible partisan or commercial influences. The type of organization, proved by the example of the large universities, the National Advisory Board for Aeronautics, and the numerous privately endowed nonprofit institutions, is the American democratic method of group control as distinct from centralized authority exercised by a single official. The undersigned panel decidedly expresses its preference, therefore, for the type of structure reflected in the Magnuson bill, S. 1285, which vests supreme control of the foundation's affairs in a board, the members of which are chosen without regard to political or partisan affiliations and solely on the basis of their demonstrated interest, experience, and competence in matters of research.

Research, by its very nature, requires a "climate" different from the technical formalities attendant on customary Government routine. The foundation should be given the widest authority to prescribe its own specific rules and regulations and to administer affairs in forms appropriate to the purpose of advancing basic sciences, and outside the usual bureaucratic routine.

e. A foundation of the size and scope contemplated will obviously require a strong and efficient executive structure. Accordingly, the director should possess the broadest powers to insure promptness and efficiency in operations. But in his capacity as chief executive the director should function under the general control of the board and should be responsible to the latter.

The board should consist of men, representing different ramifications of science and should be selected from panels submitted by the leading scientific and professional associations. The board should necessarily include members representative of engineering. Engineering scientists should also be appointed to the different committees, which are to govern the work of the divisional substructure. The board should be left free to seek recommendations for committee appointments from appropriate scientific and professional associations. No single body should be privileged by legislative acts to offer such recommendations.

f. The most crucial problem is that of men. There is need for scholars capable of creative leadership and for adequate staffs of scientifically trained personnel. The supply of such personnel has been diminishing in recent years and shows no prospect of immediate renewal.

There is no way to provide for such personnel in the future except by generously appointing promising candidates to fellowships and scholarships. The training of such future scientific personnel must be raised to the highest possible level, commensurate with the requirements of the day. To achieve this purpose, and to procure in the shortest time an adequate host of properly trained men, may require policies and procedures in the way of fellowships and stipends which might substantially depart from previous practices and would boldly cut across routine. The foundation should be given the broadest possible freedom of action in this respect.

The natural seat for the trraining of personnel is the universities. Except for a few privately endowed nonprofit institutions and certain Government laboratories, the universities will also be the natural center for basic scientific research. By contrast to the Old World prototypes, where for centuries the universities flowered as centers of creative scientific activity, the American university in the past principally served the purpose of mass instruction. The duties connected with teaching left no time and opportunity to the academic personnel for scientific research and advancement. Under the stress of the new national reqlurements the climate of university life will necessarily have to change. The foundation in its policy of contracts and subventions should be free to exercise such powers as will allow university research to be located in surroundings where the scientifically minded staff will be able to devote the necessary time and effort to scientific pursuits free from the consuming burden of academic routine.

g. In laying emphasis on basic scientific research as the prime objective of the proposed foundation, this panel fully recognizes the fact that it is not always possible to draw the delimiting line between basic and applied pursuits. It is obvious, on the other hand, that all such activities as experimental researches looking to the development of new or the improvement of existing processes and devices, or the preparation of plans, specifications, standards, economic and industrial studies, or the experimental operation of pilot plants should not be included in the function of the foundation. These most necessary and useful activities are the proper function of private industry, industrial research laboratories, engineering organizations, and the appropriate Federal, State, or municipal agencies. A National Research Foundation should not only refrain from duplicating such activities, but should not utilize its facilities or enegies for the immediate commercial advantage of any group of citizens. On the other hand, the work of the foundation will ultimately aid all practical endeavor by extending the limits of basic knowledge and by increasing the supply of men trained for research.

h. An essential condition to the success of a foundation dedicated to the advancement of basic sciences, is to divest such foundation from all duties and functions which are essentially alien to the spirit of free scientific pursuit. A most important instance of this character is the question of patents. The subject of patents is highly controversial. Patents have been qualified by some as "the life of research." Others are inclined to consider the very idea of patent protection as "an embodiment of monopoly." This panel understands that the whole subject of future national patent policies is in the process of consideration by special legislative agencies. In view of this fact and pending the forthcoming patent

legislation, a foundation dedicated to basic scientific research should be held free from any connections with predetermined patent policies. Moreover, patents have to do primarily with applied or industrial research, as distinct from the basic scientific research with which the foundation should be concerned. If the foundation is properly set up for the object of advancing basic sciences, the question of patents will not be serious, and in rare, exceptional instances, could be properly handled under the provisions of the general patent law through appropriate contractual relationships determined by the board.

SUMMARY OF CONCLUSIONS

1. The development of basic scientific research on a scale commensurate with the dominant position of the United States of America is a problem of pressing national necessity. The magnitude and urgency of the task make indispensable Government support of such research through a National Research Foundation.

2. Federal funds, administered by the foundation, should be allocated for purposes where Government support is indispensable, and should not be diverted to fields where research may rely on other sources. The proposed National Research Foundation should promote basic scientific research only, leaving applications to industrial and technological practices to the appropriate private, industrial, and public agencies.

3. Basic scientific research should include fundamental research in engineering sciences.

4. Social studies should be the object of a separate agency.

5. The preferable form of organization is to have control of the foundation vested in a board appointed solely on the basis of scientific competence, and outside of any partisan or political consideration. The director of the foundation should be selected by the board and be responsible to the latter.

6. The foundation should be given the broadest authority to enact its own rules and regulations in all matters concerning basic scientific research, in subsidizing the training of future research personnel, and in matters of publication.

7. Engineering science should be recognized in the forming of the board and the divisional substructure.

8. The legislative act establishing the foundation should be confined to the sole purpose of advancing basic science and should not include controversial legislation dealing with patents.

Respectfully submitted by the afore-mentioned panel appointed by action of the engineers joint council.

Boris A. Bakhmeteff, *Chairman,*
Honorary Member, American Society of Civil Engineers.
Dr. Harvey S. Mudd, *President,*
American Institute of Mining and Metallurgical Engineers.
Prof. A. G. Christie, *Past-President,*
American Society of Mechanical Engineers.
F. Malcolm Farmer, *Fellow and Past-President,*
American Institute of Electrical Engineers.
Dr. George Grainger Brown, *Past-President,*
American Institute of Chemical Engineers.

Dr. Bakhmeteff. May I be permitted to speak orally on a few outstanding points, and then maybe my colleagues here might be able to give a little more detail.

I think it goes without saying and you will probably understand by our professional standing that we are deeply interested in research because actually most of the research which is going on is done, particularly in the applied field, by engineers, so we feel that we are experts in that field and we are extremely anxious that the whole thing be done properly, and I want to say at the outset we unreservedly stand as a profession back of the general aims which are announced in this legislation.

We make a very clear distinction between two kinds of researches. On the one hand there is applied research in which, as a matter of fact, most of our engineers are particularly interested personally, and which

deals with applying basic principles of knowledge to the processes, products, and so on, and then this basic research—in other words, discovery of the basic fundamental laws of nature, of natural powers, resources and so on. In that, too, of course, the engineers are very much interested and we speak here in this statement of the particular role which that basic engineering research has played in the development of that might which Germany built and of which we nearly all became the victims.

This distinction really is something that determines our whole position in this situation, Senator Kilgore. We feel this: We feel that applied research, in general, which has been taken care of by industries, by different institutions and so on, is pretty well taken care of in the United States. In other words, we know that what they call Yankee ingenuity and private organizations have done wonders, and we don't feel there is really any necessity to spend taxpayers' money and to divert the very important aims of the foundation to something that is going on satisfactorily already.

On the other hand, in this basic research the United States has not kept pace with the situation, and for reasons which historically can be very well explained. Quite a lot of that stuff was coming from Europe.

In other words, we were not self-dependent in basic scientific research, and in this particular we want to emphasize with all possible emphasis that we realize we are up against a situation which is not only of great national necessity but which really involves quite a lot of danger. Unless we do it quickly and do it very well and generously, we might lose that dominant position which we have acquired through the war and which has been thrust on us, and that position, of course, is not only a position in military things—and in military affairs we know now very well that actually war is a battle between scientists—but in all the other matters we are all concerned about—national welfare, maintaining wages, maintaining productivity, and so on.

Since we have lost Europe, it is just like losing the source of rubber. We have to remedy the situation with tremendous energy, with tremendous alacrity, and for that reason we believe that it cannot be done otherwise than by putting Government funds into a thing and by establishing a centralized national agency in the form of a national foundation.

We feel, however, as I said, that the foundation should be limited or primarily, at least, designated to do fundamental research, and the other research can take care of itself. Just because all of us have been in research practically all our lives, we are very anxious that it be done in a way which will expedite results to an optimum achievement and in the shortest period. We know more or less that research isn't a thing that you can organize like a corporation, let's say, organizes production or Government organizes a certain function.

If I may be allowed to use a comparison, I am rather fond of flowers, personally. No totalitarian despot, no executive officer, no head of a government, whether his is malevolent or benevolent, can make a flower grow faster than that flower grows. It has to obey the natural laws, and it is a very delicate spiritual and intellectual realm in which scientific research goes on.

Scientific research goes on by growth and by expansion of human talent. And the thing is to take scientists—and there aren't so many

of them; a lot of people say we have many, but I can tell you from my experience, and I have been in fundamental research, not applied research, all this time here, there aren't so many people—and put them in an environment where they can blossom and bear fruit.

We have been giving the matter consideration and we fully understand all the arguments that have been brought forward, for example for the type of organization as reflected in the bill that bears your name: In other words, to have a Director appointed by the Government, something like the head of a Government department, and then have an advisory council; as against the other bill which bears the name of Senator Magnuson, and we feel the purpose would be better served by the type of organization which is offered by Senator Magnuson, we all work in corporations where there is a board of directors and an executive; we are connected with universities where there is a board of trustees and a president appointed by them; and I don't want you to feel that we do not understand the necessity of having a strong executive. That executive should be strong and powerful and independent and efficient as he can be, but we think that the problem is so unprecedented and it is so urgent and so important than in many ways The Foundation will have to cut through a lot of routine and so on, and a Government official will never have that freedom of vision and freedom of action that a board of scientists or men who understand about research—and that, of course, is the most important part—will have. We feel rather strongly about that.

Of course, we think that engineering science should be recognized. It is interesting that neither of the bills even deigns to mention engineering science, and we know that really in both the military matters and in welfare and everything else, basic engineering science is one of the most important things. We think that life will probably thrust it in, but it should be recognized in some proper way, both in the aims and I would say in the appointments.

We think also that when these committees that want all those things are appointed the Board should have great freedom in selecting panels, in getting panels from organizations which are the most active in the line. One of the bills, for example, mentions that all recommendations should come from the Academy of Sciences. With due respect to the academy, we do not believe one institution is qualified enough to give all advice.

The last point, because I want to be very brief, is this: We feel that in itself this promotion of basic scientific research and, as I say, filling the gap and putting American basic research on a self-dependent basis, is so important and such a big task that the foundation which should be entrusted with that should not be encumbered with any other things which have nothing to do with that research. Also if it is fundamental research—and we think that is the important thing—the patent situation is of secondary importance because as has been very clearly said here, in fundamental research there are very few patents.

We fully agree, I think, with what I heard you express here, Senator Kilgore, that there have been a lot of abuses in the past and that the patent situation needs a thorough housecleaning and revision. We think, however, that patenting is such an important task that there should be no hasty action. We believe that patent legislation should

be discussed in a special body, as I think it is now, and I hope that the engineers will be asked to express their opinion.

I think we can very nicely tell what we think about patents, but for the moment we feel that the purpose would be better served if all these patent clauses, if all this patent situation, should not be put into this legislation but kept apart for separate legislation, leaving maybe to this board, those very exceptional cases, such as the vitamin case that you mentioned, which situation might arise, to act appropriately under the present patent law.

I have omitted a question which I thought I would mention here. We notice that in the last drafts, the social sciences have come in. I think that the engineering profession as a whole, Mr. Chairman, are very conscious about social problems. As a matter of fact, the engineer deals with men. We come in direct contact with men who are, so to say, the embodiment of social problems, and we are all for social progress, in science, in the betterment of relations, and so on. We believe, however, that social sciences are important enough to be placed under a special roof, and I tell you my particular reason for this.

Both in your bill and Senator Magnuson's bill there is a very important clause where it is said that that National Research Foundation must be administered outside of any political influences—in other other words, in a climate which is purely scientific.

The CHAIRMAN. No; it doesn't say in a climate where it is purely scientific; it says outside of political influences. That might get into the psychological department or the philosophical department or any one of many departments in any university, and still be nonpolitical.

Dr. BAKHMETEFF. Yes; I know.

The CHAIRMAN. If you got into the department, you would find the department was highly political.

Dr. BAKHMETEFF. That is unfortunately so—if it is.

In other words, I would like to see that National Research Foundation composed of the most efficient and the most effective men, and as I say, without any relation to their social affiliations.

Now the natural sciences, of course, deal with the immutable laws of nature and politics doesn't enter into that. The social sciences, of course, on the contrary, deal with changing relations between men and you can't help in appointing for example, members of a board which is going to deal with social sciences, to find there is going to be a lot of pressure from pressure groups, and so on, and it must be an entirely different type of men who administer the one and the other, and our idea would be this: We think that a social-science group, and a science group or a basic research group, will benefit tremendously by mutual contact, and I think that each can teach the other one something, but we feel that the purpose of your legislation will be better served if they are kept under different roofs and not fused together.

I think I have given you in this very short statement most of the important points. I don't know whether you would like our colleagues to say something, or perhaps you will ask them questions.

The CHAIRMAN. We will let them say anything they have and then I want to ask some questions. Do any of you gentlemen from either panel have anything further to say on this, because I would like to

ask some questions then of you two gentlemen and the others if they have the answers to them.

Dean HAMMOND. I think it should be said, Senator, that these two statements were drawn up quite independently. They sound as if they had not been, but they were actually drawn independently and not compared until they were completed.

Dr. BAKHMETEFF. I saw it today for the first time.

Professor RUSTON. I would like to point out one small difference and that is in the one prepared by the engineering societies. There is no comment made on the inclusion of medical sciences, that they should be limited or in any way cut out of such legislation.

Personally, I feel that they are so close to basic science that they must be included in any basic science bill, and especially from the standpoint of chemical engineering and from some close knowledge of recent war activities, it is essential that they be kept together. There are too many similarities in those groups.

I merely want to point out that in our engineering group we differ apparently from the other presentation.

Dean HAMMOND. We would not exclude the medical sciences at all, from it.

Dean MACQUIGG. We specifically mention them.

Professor RUSTON. Yes; but limiting them to not more than 20 percent, and so on.

Dean MACQUIGG. Yes; that is right.

The CHAIRMAN. Gentlemen, I have a few questions I would like to ask you, based upon these statements. One, I was rather interested in the fact that yesterday a very distinguished sanitary engineer came in and took the same stand you gentlemen take, and pointed out, in his own statement, the fact that all too frequently the results of social-science point to the need for research in the natural sciences.

One other thing, I wonder if all of you understand that this foundation does no research at all in any way, shape, or form.

Dr. BAKHMETEFF. Fully.

The CHAIRMAN. It is purely custodian of the funds and the distributor of the funds that might be appropriated by the Government on research questions. That was one of the reasons that we included the social sciences in it as one of the divisions, because the coordination that could be gotten through one foundation might be better than the coordination that could be gotten through two foundations.

Getting down to the organizational feature, I have looked at it, as I say, as a fund-handling body as far as the board of directors is concerned; or the board of whatever you want to call it, and the director. The real survey of the scientific fields and the planning of the programs falls in 1297, under a purely scientific group that makes the plans and presents them to the board and the director to see how the money shall be allocated. It is based somewhat upon corporate organization in which the board of directors represents the money and the research group furnishes the plans and allocates it.

I am wondering if you looked at it from that viewpoint.

Professor RUSTON. Senator, I think the experience with OSRD rather pointed to the type of enterprise that can be operated by scientific heads, scientific brains.

The CHAIRMAN. Yes; but you must realize that OSRD operated under extraordinary conditions, which would not, we hope ever recur again, and would not be the case under this foundation.

There is another problem that was brought to my attention by the statement of Dean MacQuigg. You may not realize it but I think if you will review it you will agree:

Recommend that amendment to provide for board, not more than four members of the board shall be full-time Government employees, including military personnel.

Have you ever thought of the governmental problem of doing that?

Dean MACQUIGG. What do you suggest?

The CHAIRMAN. Do you suppose if you appoint the Secretary of War as a member and neglect to appoint the Secretary of Navy, that Navy won't feel they were left out in the cold?

Dean MACQUIGG. May I say, sir, that under that plan we wouldn't suppose that the Secretary of War would actually be a member of this board. He might and could well be, but he would delegate somebody. The Secretary of Navy would delegate somebody. Then you still have two, one from Commerce—I am being specific, of course—you would still have one from Commerce and one from Interior.

The CHAIRMAN. How about the Secretary of Agriculture, then?

Dean MACQUIGG. He is taken care of by legislation that goes back to 1887.

The CHAIRMAN. So are the others, because this in no wise interferes with the research programs as they exist. This is an augmentation to their research programs, where they can show a need exists. So the Secretary of the Interior would feel, "Well, now, I am being left out of this thing and my Bureau of Mines is going to get a kick in the teeth." Or the agriculturist would say, "My extension courses out at the universities are not going to be adequately financed."

Dean MACQUIGG. There are many, many millions of dollars expended in Federal research, sir, every year, under laws that go back to the original Hatch Act of 1887, that takes care of agriculture, so we haven't been concerned here. We might go along and borrow sufficient trouble by saying, "Who is going to take care of the Indian affairs?" We have to draw the line somewhere, Senator.

The CHAIRMAN. But you can draw the line by recognizing departments. I am not just talking of numbers. If you noticed, in the draft of 1297, we left the number of the board completely out and put the problem up to the President to see that there was the equivalent number of non-Government personnel on the board to the number of Government personnel that might be there, and left it up to him, with the director coming from the public and not from the departments, which would give—shall we say you put five Government personnel on, and five non-Government personnel, and then the director being really a non-Government person—five on one side and four on the other, or six on one side and five on the other.

Dean MACQUIGG. May I say, sir—and please understand I am not trying to be controversial, Senator, but you have asked us what we think about this. I think we would say in that case that this is not for Government research necessarily. It is for the whole field of research.

Government will be taken care of, the Navy's specific needs which are definite, the Army's specific needs, agriculture's specific needs, by other legislation which is going ahead, and, therefore, we are not, speaking very bluntly, assuming responsibility for those activities.

We only cover something here and we set these four up—just assume a ridiculous situation in which a President might be very sensitive to pressure from his departments and he would have to go through the whole cabinet, "Have I taken care of this," and so on—"They will be in on my neck." You have to say 50–50, and that means there will have to be some civilians come in to dilute it, and pretty soon you would get a large board. Maybe those similes are ridiculous, but they could happen, and we have been aiming, sir, at simplicity as much as possible.

Professor RUSTON. Senator, I would like to point out one point made in the report of the engineering societies. I would like to read it to give emphasis to it:

> The preferable form of organization is to have control of the foundation vested in a board appointed solely on the basis of scientific competence, and outside of any partisan or political consideration.

The idea behind that is that persons be appointed to the board because of their scientific competence and not because they head any department—not the Secretary of War or the Secretary of the Navy, per se—but from the Army or Navy the competent scientific personnel.

The CHAIRMAN. Do you suppose if you put Admiral Bowen on the board, even without a uniform, that the top research man for the Army would not feel that you could not divorce Admiral Bowen from the plasterboards and gold braid?

Dean MACQUIGG. He shouldn't be divorced. He should be there as a Navy man, morning, day, and night.

The CHAIRMAN. All right, that is why I say what you are up against in formulating a board.

Professor RUSTON. Senator, there is a fundamental point of difference between the engineering societies group and their recommendation, and the other group.

Dean MACQUIGG. Yes; of course.

The CHAIRMAN. Let's go over to my profession, which happens to be law. Have you ever read the Constitution of the United States on the qualifications of a judge of the Supreme Court?

Dr. BAKHMETEFF. I think so.

The CHAIRMAN. He doesn't have to be a lawyer.

Dr. BAKHMETEFF. I know that.

The CHAIRMAN. He doesn't even have to be a member of the bar. So far as I know, there isn't a single State in the Union that has a qualification for a judge, for a district attorney, or for a prosecuting attorney, but no President would put somebody on the Supreme Court other than a top-flight lawyer, or on the circuit courts of appeal.

I have been worrying how to define a scientific board that would not step on some particular group's toes by excluding them.

Dr. BAKHMETEFF. Perhaps, Senator, if I might be asked, the easiest way to do it is something which complements a very important statement which you made here, that all of this is in augmentation of existing legislation.

It so happens I have been for the last few years the chairman of the hydraulic division of our society and we come in very close contact all the time with the big laboratories of the Government—that means the Reclamation Service laboratory, the TVA, the one of Army engineers in Vicksburg. They are all represented on my committees. We cooperate very closely.

Our interest is to get the research and results out in papers. They get a lot of money for their applied research. But when you ask them, "Couldn't you summarize all this research that you have done on a dozen dams and, not attached to Boulder Dam or Parker Dam, but give us some information, some basic science on dams?"

They say, "We have no money, we have no authority. If I went over to my chief, he would tell me, 'Young man, you are trying to do something that you are not authorized to do, and keep quiet.' "

Our conception is that applied research will remain as is and the necessities of the Army and the Navy are going on. This, as you say, is something supplemental, which does not concern the Navy separately or the Army separately, which concerns general knowledge, so there is no necessity of having those department heads on the Board.

The CHAIRMAN. I was climbing up out of the hull of a partially completed ship some time ago, in company with a marine engineer, and somebody stepped on my fingers on the ladder. The marine engineer grabbed his pencil as soon as he got on deck and started figuring a change of design which would prevent that.

Now, this foundation has two purposes. One, the promotion of the general welfare of the Nation. We conceive Government as not here in Washington. We conceive Government as existing in every home.

Dr. BAKHMETEFF. Obviously.

The CHAIRMAN. The people here in Washington are just hired hands, carrying on the detail. So the foundation has two purposes: First, it must, if it is successful—and that is what the scientists want—administer to the needs of those people by the necessary fundamental research which will constantly improve their condition, as has been going on for generations and generations and generations.

Second, in improving that, as a part of that program, it will develop more and better scientists. One goes to results. The other one goes to development of people to produce results.

We, as officials, have to look to both features of that, in building it up and implementing it, and that is why we are puzzled as to how to properly implement it.

Another thing we have to look to—and this can go on the record—is appropriation.

Dr. BAKHMETEFF. That is the most important thing.

The CHAIRMAN. Future appropriation. Later somebody may say, "This is just a scientific plaything." The first thing you know, the appropriation is gone. You know what happens after every war. We could get billions when the enemy was thundering at our gate, but the minute he quit thundering, we cut taxes, and it is hard to sell bonds.

The military features of this bill really go into applied sciences, those are the only features that do, but they go into application of engineering principles in applied sciences, and the medical goes into the chemical field.

Dr. Bakhmeteff. On that we are with you.

The Chairman. The others are pure science. The others must be confined to pure scientific research, which constitutes the foundation stone for the applied research of 25 years from now.

Dr. Bakhmeteff. Other people do it.

The Chairman. Twenty-five years from now, the theories developed by other features of this are picked up by somebody and applied to a better living condition, a better machine, a better tool, a this or that, but the medical and military features do go in and must go into applied science.

Dr. Bakhmeteff. I agree with that.

The Chairman. Of course, they must do basic research but basic research and applied science must go into both those fields.

Professor Ruston. But, Senator, you touched one subject that is the heart of the matter here, regarding the use of Government heads of other agencies as necessarily being Board members. There being competition between them for Government funds, I think it would be unwise to have Government heads participating in this organization, whereby if research work more properly carried on by the Navy is simply sloughed off to a fundamental research agency, it helps to kill the very purpose for which it is established, namely, fundamental research, and the Army and Navy would still be carrying on applied research, which they should do. Primarily, this agency should be carrying on the fundamental research.

The Chairman. And with a properly constituted committee down there, to apply to it, they are just going to have to go on using their own funds for applied research, unless they can show that something has happened that they were not able to foresee.

Dr. Schimmel. Dr. Bakhmeteff gave a perfect example today of a departmental program based on applied construction, which applied some theoretical summarization that the department wasn't equipped to do and the foundation would have to cooperate with the department in working it out, which your society would presumably be deeply grateful if they would do.

Dr. Bakhmeteff. No; I could do an even simpler thing in that case. All you would have to do is to give them a little money and they then could do the summarizing, as otherwise they could not get the money from the Department.

The Chairman. I think you had something you wanted to say.

Dean Hammond. I would like to say this, so far as I am personally concerned I don't care whether there are nine members of the Board or some other number, so long as it is essentially a civilian Board. Secondly, I think the example of NACA is perhaps the best one to follow, so far as the Government examples are concerned for the organization, both of the Board and of the agency as a whole. It has been very successful. It has representation, very good representation, of the military departments.

The Chairman. Doctor, I agree with you on one feature. However, NACA has been really able to program more than a general foundation could program. They have been able to lay down definite objectives and not pour some water on the desert sand to get the plant to grow, which I think is absolutely essential in this.

I think there must be the greatest possible type of freedom exercised in the use of the major portion of the funds by just simply placing them in the proper hands to use, and getting the necessary reports in.

Dr. BAKHMETEFF. Putting the seed in the proper soil.

The CHAIRMAN. NACA has always had a wonderful program, and very definitely worked out, and their accomplishment has been marvelous, but I think we have to have a little more fluidity, probably, in a foundation of this kind, than we would have in NACA.

Dean HAMMOND. But I am merely talking about the method of organizing it.

The CHAIRMAN. I mean organizationally. There must be more fluidity in the organization. It must be a little more representative of a cross-section of the country.

Dean HAMMOND. Isn't that pretty well provided for by the make-up of the subboards, of the five divisions of the organization? You have the Division on National Defense, for example. Wouldn't there be adequate representation of the Government departments through those?

The CHAIRMAN. There would be through Army and Navy and on Public Health there would be representation. There would be no representation of the other Government departments any place.

Dean HAMMOND. Why not Bureau of Mines, for example, on the Division on Science and Technology.

The CHAIRMAN. I am talking about mandatory representation. There is no mandatory representation any place else except in those two divisions.

Dean HAMMOND. Wouldn't it be natural, in any make-up of those divisional committees, to have pretty adequate representation of the different Government departments?

The CHAIRMAN. I think it is provided for enough but I think that that division of the foundation must be purely scientific, 100 percent.

Dean HAMMOND. That is right.

The CHAIRMAN. I am thinking of the make-up of the Board, which I call advisory merely, but which is required to give a report, something other advisory boards here in the past have not been required to do, to report all their findings to the Congress and the President and to the Director. That was my thought in making the Board advisory, that you really have what amounts to your policy board at the planning level consisting of purely scientific personnel.

We won't argue on that. I am interested in these things because this is a laboratory problem with us, just like you get them, too.

Professor RUSTON. Of course, Senator, there is quite a difference in the two bills on that point.

The CHAIRMAN. I know.

Professor RUSTON. As I understand it, your bill includes the other Government agencies, that is, to coordinate activities of all Government research agencies.

The CHAIRMAN. Senator Magnuson is with me on that bill, too. You know he has half of one bill and all of another.

Professor RUSTON. As I read the Magnuson bill, though that is rather specifically——

The CHAIRMAN (interposing). I like to speak of them by number, because they represent two theories of organization only, that is all. We got into a discussion of patents.

The Patent Commissioner, as you probably heard, made this statement:

> Many of the witnesses who have appeared here have opposed this provision—

speaking of that patent provision, not of the October 8 draft—

> as patent legislation beyond the true scope of the bill. I do not agree that this is patent legislation. It in no way affects or alters the patent law or its administration. It merely expresses the national policy with respect to patents procured upon inventions made at the public expense.

(Off the record.)

The CHAIRMAN (continuing). This is simply an effort not to touch patent law, but no attempt to freeze patent policy on the Government on funds related to research.

Of course, it goes to all departments. It not only affects this bill; it affects money appropriated otherwise. And, of course, it would be used largely in the question of applied research under national defense and health and medicine, but there might be occasions in which it would apply to basic research.

You might have something develop out of a basic research problem that should be patented. I conceive of the patent feature of this bill not really as a patent. It is a dedication of the result, to prevent monopoly by any individual of the results of that particular research. It means a dedication to the public of the results of the research, in prevention of some one individual monopolizing that result himself.

For instance, we had one man in the other day who said:

> Suppose we have developed a certain kind of steel and then you come in and we improve that steel; then we lose all our former work which we did 10 or 15 years ago.

It doesn't, at all. He still has all the use of it and everything else, and anybody who wanted to use the improved steel would have to get a license for the basic principles which he had developed, before they could develop the new steel. So it would not affect his own patent rights to that particular metal, unless he developed something entirely different. Then, of course, if he did, that particular new development would be dedicated to the public use.

That is my theory on the patents, and that, I think, was what the Patent Commissioner was testifying about. That, also, I think, is his theory as a patent lawyer, that it is not really a patent, it is just a dedication to prevent somebody grabbing it off later and utilizing it.

Mr. FARMER. Senator, isn't publication a sufficient preventive of that situation?

The CHAIRMAN. I doubt it very seriously.

Mr. FARMER. I think we feel very strongly that is the best way to get results obtained at the expense of the public, to the public and for the public use.

The CHAIRMAN. Frankly, that is the finest way of buying your lawsuit that you ever saw in your life.

Mr. FARMER. We all know about lawsuits in patents. We engineers fully understand that.

The CHAIRMAN. You have to go back and dig out some magazine some place and say, "This was published way back," but in the meantime you have that most beautiful thing, that injunction, to prevent your using it. That is what puts the little fellow out of business when

he goes into business. It is not the loss of the patent suit; it is the injunction features that knock out his emolument.

Mr. FARMER. That is correct, but I think if this material, the information that is developed from these researches and investigations, is properly handled by the foundation—and we assume competency——

The CHAIRMAN (interposing). I am really in hope that some system can be developed by which that matter can be filed in the Patent Office as a place of record. Don't you think that can be done? That is why I asked the Commissioner to work it out.

Mr. FARMER. That would be publication in another form.

The CHAIRMAN. That is really what it amounts to. If we call it a patent application, it really amounts to filing of the information in the Patent Office, as notice to the world that this thing has been done before.

Mr. FARMER. You say that publication is a questionable means of getting this information to the public?

The CHAIRMAN. The reason we said patents was because we were trying to live within the present patent structure.

Mr. FARMER. We understand the present patent situation is about to be overhauled and perhaps even more or less improved.

The CHAIRMAN. I am 52 years old and I can remember back at least 35 years reading of threats to correct patent structures, in the newspapers, and so far it is just like the weather.

Mr. FARMER. That is one reason why we feel if the patent feature is left out of this bill, it would be advantageous.

This publication business is a matter, I think, of the way it is handled. Under the foundation there should be machinery set up to get adequate publicity, so that anybody having any interest in a project——

The CHAIRMAN (interposing). Bill 1297 provides for a foundation publication.

Mr. FARMER. That ought to be sufficient, we think, if proper publication machinery is set up.

The CHAIRMAN. There is another point you talked about, Dr. Saville, 2 years ago. There is another injunction in this bill 1297, which places upon the director the duty, the right, to protect freedom of discussion on the results of research, because there had been a fear expressed in past hearings by numerous scientists and engineers that if they ever got any Government money they would have to keep their mouths shut all the time. We realize in defense research there must be injunctions of that kind, but in the rest of research there need be no injunctions of that kind at all.

Dr. BAKHMETEFF. The practice of the Government bureaus is very much to keep their mouths shut too much. When I come in contact with numerous people who are doing research and ask them to give this fact or that fact to us, not one man dares say a word, or give us a figure or a phrase, without getting release and sanction from his chief. It is terrible, Senator Kilgore.

The CHAIRMAN. Gentlemen, you come over and get on a Senate committee for 3 or 4 weeks and I will show you. You will really get your eyes opened.

Dr. BAKHMETEFF. Senator, this gentleman is a very wise man and stands high in the profession. I wish you would ask him a few questions.

The CHAIRMAN. I would just like to get all your impressions on this. My questions have been aimed at the whole panel always. Any of you are at liberty to answer.

Professor CHRISTIE. My own reaction has been to leave the patent situation to revising of patent laws. I don't think that you are going to get very much protection if you take patents and give them nonexclusive license, because the fellow that has the big facilities will immediately grab it and develop it and monopolize it while the small fellow gets no protection.

The CHAIRMAN. The Patent Commissioner seems to feel he can redraft this law in such a way that it gets really what we are after. We have always found——

Professor CHRISTIE. How could he prevent that?

The CHAIRMAN. There is no way of preventing that. There is no way of preventing that any time.

Professor CHRISTIE. Then what is the advantage of patenting?

Dr. SCHIMMEL. Senator, may I explain the difference between publication and patenting in the latest draft? That, I think, is the real problem. Most of you gentlemen are referring to the earlier draft of S. 1285. Under the present draft of the bill, the whole policy is essentially one of publication and free dedication.

Dr. BAKHMETEFF. You mean 1297?

Dr. SCHIMMEL. 1297 revised. If an inventor who happens to be under this contract decides despite the fact the entire policy of the foundation, of the Government, with respect to research under Federal funds is publication and free dedication, decides that under the patent law he has a right to go in and get a patent, then after he does that, he discovers that his contract of employment said that he was in the position of having fully published and freely dedicated, and this in effect is the contract of employment under which every one who works with Federal funds will operate: That is the full publication, free dedication policy.

The only exceptions that are made are exceptions made at the request of the industrial contractors who will be handling national defense contracts, who will come in and say, "We already have a great deal of money invested in this particular type of research, and if there is a patent forthcoming it is not fair to have full publication and free dedication," and then an exception is made and it is that exception to which Commissioner Ooms referred this morning that he was not sure that it gave full protection to the industrial concern that took the contract.

Dr. BAKHMETEFF. It leaves to the discretion of the director to agree or not.

Dr. FARMER. That is the point.

The CHAIRMAN. Of course, that is always subject to appeal.

Dr. SCHIMMEL. He wants to help work that out so there won't be any misunderstanding.

Professor CHRISTIE. What would be the protection of the individual researcher who spends all his life with an idea and then gets some Government money to finish it off to invent it? Does he get nothing from his life's work?

Dr. SCHIMMEL. Presumably this is modeled after the normal procedure.

The CHAIRMAN. He has the right also to come before the director and say, "I have spent all this time and all this on this, and I have certain rights. Let's take the same man who files his patent and doesn't get any Government funds. In the meantime, somebody else has been working on the same thing and he runs into a lawsuit. In this we just provide a way for settling that dispute. If Government funds are involved in it at all he comes in and says, "I had far more than the Government had and I should be protected, and I disclosed that to you when I came in, that I had this much worked out in additional funds."

Dr. FARMER. I think probably it would be a fair statement to say he would have more protection in appealing to the decency and so forth of the board, or the director, than he would by the patent laws.

The CHAIRMAN. Than by just a lawsuit.

Dr. SCHIMMEL. The Fulbright bill, as a matter of fact, goes into very considerable detail on the problem of individual inventors, and I think it even allows for joint collection of royalties between the Department of Commerce and the individual inventor. This bill primarily operates through institutions.

Dr. BAKHMETEFF. The Fulbright bill really doesn't refer to Government research. It gives a possibility for any individual to go and get Government protection of his own work.

The CHAIRMAN. But it is complementary to and not in conflict with this bill, because it applies to commerce only. For that reason we are going to have separate hearings on it, because it has been held that the two bills are not conflicting in policy at all.

Professor CHRISTIE. There is one more phase of the problem that has not been discussed that I would like to call to your attention, Mr. Senator, and that is the supply of trained scientists. I think I can say rather frankly that there are practically none being trained today. The colleges are practically cleaned out of graduate students. The boys that are coming out of the Army are older, are married, can't see how they can spend several years in scientific training with a wife on their hands, usually, and I think the colleges are in about as bad shape, their faculties have been taken away, and then we have industry offering enormous salaries to these fellows to go into industry. So there must be some special inducement brought in very quickly or we are not going to have the scientific leadership in the world.

The CHAIRMAN. You are absolutely correct.

Professor CHRISTIE. And England, which has not sent their college men to war, their engineers were deferred, the Canadians were deferred, and they are going to step ahead unless we take some action here quickly and build up that reserve which we need for scientific research.

The CHAIRMAN. Doctor, I tried to prevent that——

Dr. BAKHMETEFF. It is a very essential factor in the present situation.

The CHAIRMAN. I tried to correct that one time with a bill I never could get anybody to understand, when I wanted to draft all scientific students and send them back.

Dr. BAKHMETEFF. I wish you had, Senator.

78860—45—pt. 3——18

The CHAIRMAN. But it was misunderstood. They thought I was trying to draft them, but my idea was to send all the promising ones back to complete their course and then use them in the Government service until the war was over.

Professor CHRISTIE. There is another factor there, Senator. I think if we check up colleges today we will find maybe the majority of the graduate students who are getting scientific research in engineering are from foreign countries.

Dean HAMMOND. This may not have any direct bearing on this bill, but I would like to say for the record that the situation in the colleges now is a desperate one.

The CHAIRMAN. And it is a desperate one in the laboratories, too, and we are trying to get it corrected.

Professor RUSTON. Just one other thing, Senator, off the record.

(Off the record.)

The CHAIRMAN. I have a prepared statement from Mr. Cardon, Administrator of Agricultural Research Administration, which I will make a part of the record at this point.

(The statement follows:)

PREPARED STATEMENT BY P. V. CARDON, ADMINISTRATOR, AGRICULTURAL RESEARCH ADMINISTRATION, UNITED STATES DEPARTMENT OF AGRICULTURE

Since Secretary Anderson was unable to accept an invitation to testify at this hearing, I was asked to appear before the committee in his stead.

I am pleased to have been accorded this privilege. I welcome the opportunity of expressing viewpoints and offering suggestions that reflect in some measure the thinking of leading research workers of the Department who have made an effort to examine bills recently introduced to promote and support scientific research.

Scientists in the Department of Agriculture take a constructive interest in all proposals which through suitable legislation aim at improvement in scientific research. We realize that the effectiveness of our research is in proportion to our ability to keep pace with the advance of science generally. The extent to which we may contribute to that advance and in turn utilize the contribution of other research agencies will continue to be the measure of our accomplishment.

Research in the Department of Agriculture is administered through the Agricultural Research Administration with a view to the fullest possible integration of effort among the several scientific bureaus of the Department. We clearly recognize the functions and responsibilities of each bureau, and seek by joint thinking and the development of common understanding of problems to strengthen the research that each bureau conducts. As Administrator of Research I rely upon each bureau chief to direct his organization in the light of a common understanding of interbureau relationships. It is with these interbureau relationships that we are particularly concerned in effecting coordination. Such coordination we seek to accomplish, first, by joint consideration of the problem confronted; second, by agency assumption of the respective research aspects of the problem; third, by project development; and fourth, by cooperation in carrying out the objectives of the related projects.

Among the units grouped within the Agricultural Research Administration is the Office of Experiment Stations, which is responsible for the administration of Federal grant funds to State agricultural experiment stations. This involves the approval of research projects conducted by those stations under the terms of the Hatch, Adam, Purnell, and Bankhead-Jones Acts of 1887, 1906, 1925, and 1935, respectively. Thus through the Office of Experiment Stations as regards federally supported agricultural research by the State stations, the Department is in a position to promote coordination of research among those stations themselves, and, through the Office of the Administrator, to promote coordination and cooperation between the State stations and the Department, and among the various bureaus of the Department.

This Federal-State Nation-wide coordination has been in progress in steadily increasing measure for many years as the result of joint consideration of problems of mutual interest. The creation of the Research Administration in December 1941 was with a view to promoting still greater effectiveness in the field of agri-

cultural research coordination. This was particularly fortunate during World War II, because through the Administration, agricultural research was so coordinated as to bring about the greatest possible contribution to food, fiber, and special crop requirements and utilization. From several of the war agencies, including the Army, Navy, War Production Board, and the Office of Scientific Research and Development, we have been pleased to receive recognition of our achievement in certain types of research directly concerned with urgent war problems. Our contribution to a solution of these problems may be traced to the rich background of our research experience, the development of special skills among our scientists, and a broad familiarity with underlying physical and biological principles. These intangible but extremely important assets grow out of continuity in research, flexibility in the organization of research, and individual freedom in the conduct of research.

During the last 3 years we have supplied the Senate Subcommittee on War Mobilization with requested reports and statements covering details of personnel and expenditures of the Agricultural Research Administration. Since those reports are part of the subcommittee's record, it is deemed unnecessary at this time to review them. Hence the remainder of my statement will be confined to the legislation proposing further Federal support of scientific research and to the type of organization that in our opinion could discharge that function most advantageously.

It is our understanding that witnesses are asked to direct their testimony to the proposed substitute amendment to S. 1297, dated October 8, 1945, although there is no restriction on comments regarding either the original S. 1297 or S. 1285. On patent utilization, the field of S. 1248, the Department has prepared a written report which I understand is in process of formal clearance.

We believe that the substitute amendment to S. 1297 contains many provisions that should make possible the development and application of the Nation's scientific and technical resources to an extent commensurate with what public sentiment now seems to favor. We desire, however, to offer for consideration of the committee some viewpoints and suggested modifications in language which, in our opinion, would be helpful in furthering the purpose of this bill. If S. 1285 should be the basis of final legislation, slight modifications of the following comments would be in order, appropriate to the language of that bill.

Section 2 of the substitute amendment to S. 1297 lists a number of objectives we can recommend for a science foundation, and on many of which I believe all scientists are substantially agreed. On some of them, however, we desire to offer comment.

In connection with paragraph (a), we assume that the term "basic sciences" contemplates coverage of fundamental research in certain biological as well as physical and chemical sciences. Such research we believe would be required in fully rounding out a program aimed at securing national defense and advancing national health and welfare. We are also pleased to note the inclusion of social sciences among the sciences to be supported by the proposed foundation. For many years the Department of Agriculture and the State agricultural experiment stations have carried on social science research, and investigations in this field have proved important in the solution of economic and social problems of agriculture. We are of the opinion that further Federal support should be extended to the social sciences, in conformity with the provisions of the substitute amendment.

With respect to paragraph (c) of section 2, we hope that it can be interpreted broadly enough to insure opportunities not only to untried young men and women of scientific promise but also to those already engaged in scientific research who are found to need further formal study in this or other countries in order that their innate ability may be developed to the utmost.

Paragraph (e) of this same section 2, relating to publication and abstracting, could, it seems to us, be made to reflect present conditions more realistically by recognizing the public and private agencies that are already engaged in publishing and summarizing scientific progress. The Department of Agriculture, for example, in conformity with provisions of the organic act of 1862, is carrying out essentially these functions in the field of agricultural research and development. Similar functions in other fields are being discharged by such existing agencies as Chemical Abstracts, Biological Abstracts, Engineering Index, and the memoir series of various scientific associations. The foundation might well cooperate with and supplement the work of such institutions through allotments and grants. It is suggested, therefore, that in order to enable the proposed foundation to take advantage of activities already in operation, paragraph (e) on pages 2 and 3 of the substitute amendment be revised to read (new language in italics, deleted language in brackets):

"(c) To compile and maintain *or to assist financially and otherwise in compiling and maintaining* [a] comprehensive [inventory] inventories of the findings and other pertinent data resulting from federally financed scientific research and development activities, and of other information on scientific and technical advances in this country and abroad and, *through collaboration among interested public and private agencies,* to make such scientific and technical information available to the public."

Concerning section 3, we feel that the provision now included in paragraph (b) for Government representation on the Board of the foundation would be necessary in order to assure effective integration between the foundation and the executive departments. This plan would also serve to avoid unnecessary duplication.

We propose three modifications of this section, all relating to the organization of the divisions outlined in paragraph (c).

First, in order to provide a more complete divisional organization than that proposed in this section it is suggested that instead of the single "Division of Basic Sciences" proposed in line 19 on page 4, there be established a "Division of Natural Sciences" to include physical, chemical, and biological research, and a "Division of Social Sciences." Bill S. 1285, as originally introduced, proposed classifying biological science within a Division of Medical Research. Since the term "biological science" covers an extremely wide field of investigation including plants, animals, fisheries, conservation, and other fields distinct from medical research, it would seem more appropriate to include this group of subjects under "Natural Sciences" rather than under "Medical Sciences." It would be simpler for the foundation to make special adjustments in the case of those biological fields related to medicine than for the Division of Medical Research to attempt to cover the entire field of biology. To be consistent with this suggestion, it might also be desirable to change clause (3) in section 4 (a), line 10 on page 7 of the substitute amendment to S. 1297, to read "(3) [basic] *natural* sciences [, including]; (*4*) social sciences;" and to renumber clauses (4) to (6) accordingly.

Second, in the interest of elasticity of operation, we suggest that the Director be authorized to modify, combine, or rename the divisions specified in the bill, with such qualifications as the Congress may deem advisable. This change could be made by the insertion of an appropriate provision on page 4 at the end of line 23.

And third, some modification of another provision of paragraph (c), namely lines 3 to 7 on page 5, would be desirable in our opinion. As that sentence now reads, the advisory committees for each Division would consist "of one or more representatives of each of such Government agencies as may be designated by the Director and an equal number of public members appointed by the Director." We would suggest clarifying this sentence and establishing a policy to guide the Director, by requiring representation from those agencies substantially working within the field of the Division, and to leave the choosing of the representative of each agency to the head of the agency. Under this suggestion the sentence beginning in line 3 on page 5 of the substitute amendment would be changed to read (new language in italics, deleted language in brackets):

"For each Division, except the Division of National Defense, there shall be an advisory committee consisting of one or more representatives *designated by the head* of each of such Government agencies as [may be designated by the Director] *are engaged in research directly related to the field of the Division,* and an equal number of public members appointed by the Director."

We have no other comment on section 4, except to note favorably the provisions of paragraphs (d) and (e) which, we believe, are intended to safeguard the functions of other Government agencies and to insure freedom in research.

Section 5 on "Scholarships and Fellowships," we regard as desirable, although as earlier indicated we would recommend that such assistance include scholarships for personnel already engaged in research, and that, where advisable, study in other countries be permitted.

Section 6, entitled "Survey of Federal Scientific Activity," in the first sentence of paragraph (a) provides that "the Director shall make and maintain a comprehensive survey of federally financed research and development activities." The Department of Agriculture would of course freely cooperate with the proposed foundation in carrying out this provision. We suggest, however, that administrative care should be exercised to insure that the cost of such surveys as may be made would be commensurate with the value received. Certainly the cost would be considerable. This cost, under the language of the second sentence of paragraph (a) would evidently have to be shared by Government agencies other than the foundation. It is doubtful if any such other agency

would be in a position to compile special data of this character without reducing the sums and time available for conducting research. In order to avert an unnecessary flow of costly reports to the Director, I should like to see the language of section 6 (a) modified to read substantially (new language in italics, deleted language in brackets):

"SEC. 6. (a) The Director, *in cooperation with other Government agencies*, shall make and maintain [a comprehensive survey] *inventories* of federally financed research and development activities. [Any] Government [agency] *agencies* shall [whenever the Director so requests] furnish [whatever] *such available* data and reports *as* may be needed for this purpose."

Regarding paragraph (a) of Section 7, the power of the foundation to require specified reports from a contracting agency or organization would appear not to be limited to the work done under foundation grants and contracts, but would apply to all activities financed by the Federal Government, which under the definition of "federally financed," section 10 (b), would include, for example, the Federal grant funds to State agricultural experiment stations. In such event, we would submit for consideration the probable difficulty of determining, in many cases, whether a given research activity had been carried on solely on non-Federal or in part on Federal funds. Some of the research of these stations is financed in part by funds from each such source. The average amount of money available to State stations from sources other than Federal grants is about three times that derived from Federal grants. In a few States the Federal-grant fund constitutes as little as 10 percent of the total fund available to these stations.

My only purpose in raising the foregoing point for your consideration is to make plain a difficult administrative problem in connection with the reports required under section 7 (a). Under the terms of the Federal-grant acts we would presumably share the responsibility of attempting to solve this problem.

Paragraph (b) of section 7 provides that the foundation shall promote widespread distribution of scientific information. We subscribe to this provision but suggest collaboration with existing public and private agencies now engaged in abstracting, translating, bibliographic work, and other comparable services. We feel that such collaboration could be assured by inserting new language in paragraph (b) on page 10, following the word "authorized" in line 1, so that the first sentence of this paragraph would read (new language in italics, deleted language in brackets):

"The Director is hereby authorized [and directed to record, collect, edit, publish, and disseminate] *to collaborate with and to render financial assistance to existing public and private agencies in recording, collecting, editing, publishing, and disseminating* pertinent data * * *" etc.

Concerning the remaining paragraphs of section 7, we have the following comments. We are in full sympathy with those objectives of the substitute amendment which aim to secure to the public the benefits of inventions, discoveries, and patents, and to promote their rapid introduction and full use. Nevertheless we feel that we should direct the attention of the committee to the experience of the Department of Agriculture in freely dedicating patents to the public as would be required under section 7 (c). This policy was the only one used in the Department of Agriculture until about 10 years ago and over 700 patents of this type have been issued on department inventions. Unfortunately the results were often disappointing. Manufacturers were loath to invest their capital in developing and advertising a new material when any competitor could manufacture the same article without much of the development cost as soon as the market had been created. Under the free dedication policy, the Department was also unable to control the accuracy of the manufacturing process to be sure that the public health and interest are protected.

Accordingly in recent years the Department has adopted additional procedures under which certain patents are assigned to the Secretary or to the United States and are then made available to all qualified applicants under revocable nonexclusive licenses. Some 222 licenses have now been issued under 48 such patents and applications for patents. In the event of carelessness or abuse, the license can be canceled and the public protected thereby. This is especially important in the case of biologicals, insecticides, pharmaceuticals, and similar materials.

However, this plan has not been fully adequate to stimulate and control the utilization of many important discoveries, even though carried up to and through the pilot-plant stage of development. Of the 275 patents now held by the Department subject to nonexclusive license, there are over 200 for which no licenses have been applied for or issued. The Department has therefore suggested that the Congress study carefully the advisability of authorizing the issuance of exclusive

licenses for limited periods in those cases where a large initial capital investment would be required to bring a product or process into use. We would be glad to have such a procedure fully evaluated as a Government policy.

Possible limitations and procedures under such authority, as proposed by this Department, were summarized in part I of subcommittee report No. 5 from the Subcommittee on War Mobilization to the Senate Committee on Military Affairs, pursuant to Senate Resolution 107, Seventy-eighth Congress. The title of this report, dated January 23, 1945, was "The Government's Wartime Research and Development, 1940–44," and the reference appears on the lower half of page 14.

We are sympathetic with those purposes of section 8 of the substitute amendment to S. 1297 which would promote the international development of science and the international exchange of scientific and technical information, and we can freely endorse the provisions of paragraphs (a) and (c) of this section. Paragraph (b), however, is such a wide departure from our limited experience that it lies beyond any comment we feel qualified to offer.

Mr. Chairman, this completes my prepared statement. I wish to assure you that my statement in every respect is intended to be constructive and in the interest of making an entirely worthy piece of legislation thoroughly workable administratively.

The CHAIRMAN. I want to express my appreciation for your coming here and giving us the benefit of your advice on this and also for the fact that you unanimously support the need for the foundation. It is just a question of our working out some implementation.

Dr. BAKHMETEFF. On that we are with you 100 percent.

The CHAIRMAN. Is Dr. Kern here? Will you go ahead, please?

TESTIMONY OF DR. FRANK D. KERN, PRESIDENT, MYCOLOGICAL SOCIETY OF AMERICA

Dr. KERN. Mr. Chairman, I have prepared a short statement embodying some of the matters that the people I represent are concerned about. After such an array of representatives, you will have to admit that one lone professor feels rather timid; and then again after so many days of hearings, I can see how that it is almost impossible to bring up anything for consideration that hasn't already been talked about and possibly the previous testimony may be more competent than that I have to offer.

The CHAIRMAN. Would you care to file your statement, and add a little?

Dr. KERN. I would say a few words about it.

What I have to say, I have divided into three parts. First, the divisions within the foundation; second, the make-up of the Board; and third, the award of fellowships.

I am a spokesman for a biological group—I represent a body of scientists calling themselves the Mycological Society of America—it may sound like a big word to some people but they are the ones who study fungi and such an example as we had during the war of the use of penicillin comes out of this sort of study.

The one thing that disturbed these people, and which may now be corrected in the revised draft, but I want to mention it, is the inclusion of all of biology under medical science. We think of medical science as being a part of biology, rather than biology being a part of medical science, and yet that may work out all right, although as I say, I have included it because that has been a point which the biologists have thought a good deal about.

The CHAIRMAN. You can see now the problem of a legal draftsman in trying to get into definitive terms that would handle the situation.

Dr. KERN. And then, another point that I tried to make, and I am not sure that I have made it as well as I should, came out here while the engineers were talking, and that is about provision that we have had for a long time for agricultural research. The biologists don't want to be caught between two agencies, one of which is interested in agriculture and in the application to agriculture, and the other which is interested in health and medical matters, because we feel that we have so much to offer in botanical science with regard to the relation of plants and animals to man. We are very much interested in the phases which assure that we are going to have opportunities for fundamental research.

How we can really be assured that we will have those opportunities is a matter for concern. Possibly the committees will care for all of that, but after a lifetime in the agricultural experiment station work of the States, some of us have found it very difficult to do fundamental research in biology with the agricultural experiment station funds, because we are told so frequently that the projects which we would like to pursue must have economic application. They even go so far as to say that we must be able to say when these projects will put money into the pockets of, say, Pennsylvania farmers.

That is impossible to guarantee, as every one knows, and yet some of those funds—I refer particularly to the Adams Fund, which, at the time of its inception was supposed to be devoted to basic research are now so regarded that it is necessary to have these applied phases.

The CHAIRMAN. Doctor, may I say to you the thing you are speaking about is the thing that first interested me in the idea of this foundation?

It has been well said that all an intelligence officer for any foreign government needs to do is to spend $0.50 a year to keep his government completely informed as to all developments that may be taking place in our armed forces. By sending down to get the record of the hearing before the Appropriations Committee by the Army and Navy, in which both branches have to go into detail as to what they expect to do with the money, that is all he needs to do to be a top-flight intelligence man for any foreign government. Under the American democratic process you have to do that, in departmentalizing the Government.

The thought was if we could get some central fund which was not directly answerable in results only—with some latitude to furnish an umbrella over those things, that could shelter the cases that sounded visionary to start out with, but not visionary in the long run when viewed by the minds of men who were capable of appraising ideas and who, unlike Members of the Congress, were tax-unconscious most of the time—if you don't believe it read our mail—we would have an opportunity, for instance in the military field, to go ahead with applied research on things.

We would have an opportunity in all the other fields to spread out on basic research on a lot of these pursuits that would look visionary before an appropriation subcommittee, but are not visionary at all when the proper scientific background is behind them, and on things you can't show a dollar return on.

You can't show a dollar return to the taxpayer even on the building of a highway. You show him a return in service, and that is my hope

on this foundation, and I think your statement here follows my line of reasoning.

The question you have is the same question all of them have, and that is what has worried me and caused me to waste a lot of scratch pads: how to take care of all the various facets of the diamond of science.

Dr. KERN. That is quite true.

The CHAIRMAN. Great knowledge only comes from high specialization, and every time you specialize you produce a new facet on the stone. The only way I could see it was to put the scientist on a definite planning level with enough looseness in that planning level so that if something new popped up you could stick a new man in to take care of that on the committees, and then they make a plan with sort of a generalized division of the budget and you constantly keep all the new developments represented as they show they are worthy of representation.

But if you try to sit down right now and say, "We shall have a division of this and a division of that and a division of the other and each one shall have definite subdivisions"—we can generalize the divisions but leave wide latitude as to the composition of the committees under them, then we approach the thing that you are talking about in which somebody capable of talking about fungi could be placed on the committee without having to amend the bill every time we got something new developed.

Dr. KERN. The reason I brought the question up is that for many years, some of those agricultural funds were used for fundamental research, but in recent years we have been told by those who are administering them through the Office of Experiment Stations that pressure is on them to get us to do the practical things, and they put all the blame onto Congress. They say the Congressmen come over and say, "What are you doing with our money?"

The CHAIRMAN. Of course, we have very broad shoulders.

Dr. KERN. They don't say that they want to insist on this kind of a program, but they say that Congress insists on it.

The CHAIRMAN. Congress practically has to.

Dr. KERN. My reason in bringing it up here was the hope that this foundation wouldn't get into such a state.

The CHAIRMAN. And that is why I hope to get through a bill that has elasticity enough in it to meet each situation as it arises without having to go back to Congress and justify an amendment, and that is why we have worked 3 years trying to get enough information together even to draw a preliminary draft of a bill.

And may I say that some of us have been called Socialists and everything else during that progress, but eventually we will get something.

Dr. KERN. It is admitted that we do have to have control of public funds. They can't just be dished out to anybody and told, "Here, this is what you want. Take it and do as you please with it." That is quite right. But rigid controls, such as you have referred to that have happened in some of those other cases, will certainly hamper the procedures under this bill.

(Off the record.)

Dr. KERN. I have for most of my life been interested in rust—rust of cereals. In recent years the plant breeders thought they had a fine

answer, resistant varieties. They found out very soon that those resistant varieties lasted for a while and then soon became rusty again. No one knew the answer and quite aside from the efforts of anyone who was working to solve that problem, people in mycological work found out that the reason was that these fungi were hybridizing in the barberry bush and producing new strains and those new strains of rust were breaking down the resistant varieties. That is a fine example of what I am talking about. The agricultural funds couldn't be used for these fundamental investigations which really finally supplied the right answer to the problem.

We are hoping that fundamental biological work will be endowed through this act, and that future interpretations to endanger the protection of basic research will be impossible.

Just a word on the make-up of the board. That has been talked about a good bit. I am not sure what I can add to that, but most of the people that I have talked to think that it should be a civilian board of demonstrated capacity, appointed by the President, who would elect the director. They think also that the President should be guided by nominations from organizations of national standing. Of course, that is something like appointing these governmental officials to the board, I suppose, because right away we would get into a controversy as to what organizations are of national standing, and many of them——

The CHAIRMAN. And there are organizations within organizations.

Dr. KERN. Many of them that shouldn't be recognized would probably want to make recommendations or nominations, and yet the principle does seem to be sound, and most of our people do not share the belief that it will be impossible to get men of high standing to serve in peacetime just as well as in wartime, provided that the organization has a set-up to which such men can subscribe.

And then, as the dean of a graduate school, I am very much interested in the matter of fellowships, because it is axiomatic that we cannot have scientific development without new workers, that the colleges and the universities, and especially the graduate schools, must furnish these workers.

Of course, we are in an awful hole right now, but we hope to be able to work out of it, but to do that we do need the help that this bill can give.

The CHAIRMAN. Then you disagree with one witness we had a few days ago who said there was an adequate number of scholarships and fellowships available in the universities?

Dr. KERN. I disagree with that.

The CHAIRMAN. I have been getting constant disagreement since. I like to pile the evidence up.

Dr. KERN. I think, although I didn't put it in here, that we should provide for the possibility of what may be called fellowships, on a fellowship basis, for men to go abroad who might not necessarily spend all of their time in this country but might have opportunities to work internationally, and on that I just want to make this point, that we are all thinking of international cooperation and international unity. I believe that the scientists have made more international progress as a group than any other set of people that we have. Natural history can make no headway without universal agreements, for example, with regard to naming and classifying of plants and animals.

The CHAIRMAN. Do you know the reason for that?

Dr. KERN. These scientists have got together; we do have international agreements, and they do work. They are not perfect, but they work, and so I feel that a good deal of work can be done by some means of sending some of our scientific people abroad and continuing this on an international basis.

So I would like to see—

The CHAIRMAN. Exchange fellowships and scholarships?

Dr. KERN. I would like to see that broad—not necessarily just exchange.

The CHAIRMAN. What we used to call exchange?

Dr. KERN. Yes; but exchange involves the idea——

The CHAIRMAN. In which our schools could send our students abroad to other schools on a scholarship. That is what we do now on occasion.

Dr. KERN. That is right, but I think we should be able to send them abroad even as representatives of our own schools, to conduct investigations in collaboration with the biologists of other countries.

And then, although I am out of turn as a representative of this society, as a college administrator I am strong for recognition of social science, and I believe that the place for it is in this bill, because after all, we hear every day about the relation of the men who do the scientific work to the influence of those discoveries on the rest of the world. If we confine it to natural science, we are dealing with the relation of man to things, and if we include social science we are including man's relation to man, and——

The CHAIRMAN. (interposing). And also things' relation to man. It reverses it.

Dr. KERN. That is right.

The CHAIRMAN. In other words, what effect does a given physical condition have on the thinking of man?

Dr. KERN. So I should like to see the social sciences brought into larger opportunity and given support for greater development of human relations, which the world certainly needs.

And then I was so bold as to have just a short paragraph on the patent problem, but I hesitate to mention it, because that is so controversial. My own personal view on that is that we do need patent reforms, but I am afraid that it will confuse the fundamental issue that we are interested in here, and I would like to see that embodied in separate legislation.

The CHAIRMAN. But you must realize that this is not a patent reform. It has no relation to patent reform. It may point to a need for patent reform, but it is simply establishing governmental patent policy for the first time in the history of the United States Government, and getting away from a very chaotic patent policy which has existed heretofore.

Let me give you an example of what our present patent policy gets us into. In 1942 I was compelled to spend about 2 weeks investigating a claim for some $683,000 on a Navy shell, which also was used by Army, which involved merely the location of a ring on the shell which had been done by a machinist at a navy yard, on Government time. He had just simply moved the ring about 2 inches in making up some test firing shells under orders of his commanding officer, and then patented it.

That has taken up weeks in the Court of Claims on three different occasions. I was informed it had taken up 2 weeks in a senatorial committee, determining whether or not he was entitled to be paid anything for a patent that had been granted. You can see that is a rather chaotic situation and it bobs up every 2 years when he gets together enough money to come and start again.

As an Army or Navy official will tell you, we have literally hundreds of those things, due, as I say, to a very chaotic patent situation existing in Government, where with a change in secretaries, a new secretary announces a new rule. Some of them leave all rules out and trust the thing will work out.

Were this an amendment to the patent law, unquestionably it could not be before either one of these committees. It would have to go before the Patent Committee if it worked any change in the patent law. What is merely does is to attempt to establish a uniform policy on what shall be done with inventions, and in looking over MIT's plan, I think it conforms fairly closely to MIT's plan. It isn't so far off in some of its respects in the latest draft.

Dr. KERN. Would it affect all work done by Government funds other than furnished through the foundation?

The CHAIRMAN. Oh, yes; why shouldn't it?

Dr. KERN. I think it should, but I don't like the idea of working that into this bill. I think it should be a separate consideration, because it is so much broader than this bill.

The CHAIRMAN. That is just what happens every time a bill comes up. You have to get it in some bill.

Dr. KERN. That is right. I just wanted to put that in the record as my thinking on the subject.

(Dr. Kern's full statement was made a part of the record and follows:)

PREPARED STATEMENT BY Dr. FRANK D. KERN, PRESIDENT, MYCOLOGICAL SOCIETY OF AMERICA

I am president of the Mycological Society of America, which is a national organization of 500 workers interested in fungi. I am professor of botany and dean of the Graduate School in the Pennsylvania State College.

After so many days of hearings I am doubtless correct in thinking that most of the matters which can be brought up for consideration have already had attention. Repetition seems not only unavoidable but there is also the probability that previous testimony may be more competent. These are chances which those who appear later must take.

It is going to be difficult for me to divorce two interests (1) as a biologist and representative of scientific organizations and (2) as a representative of college and university administration.

First, may I say that all these interests endorse most heartily the general proposals for Federal Government to promote science through research. I would like to add that while research workers everywhere are proud of their accomplishments they do not offer research as a panacea for all human ills.

I have divided what I shall say under the following headings, not arranged in order of importance.

(1) Divisions within foundation.
(2) Make-up of the board.
(3) The award of fellowships.

(1) *Divisions within the foundation.*—There is most strenuous opposition to the inclusion of programs relating to biological science under a division of medical research. This is a case of putting the cart before the horse for medical research is only one phase of the broad field of biology. Such an organization cannot provide a properly balanced program. Not for a moment discounting the importance

of the health of man, his welfare and safety depend to a large extent upon his knowledge of the plant and animal worlds. We cannot neglect the botanical sciences with their all-important ramifications in plant breeding and plant diseases. The discovery of certain facts about fungi, which have led to great contributions to medicine, agriculture, and industry, were made through basic researches and not through applied investigations.

The mention of agriculture brings up the question of the relation between the scope of these bills for the promotion of science through research and the provision of Federal funds for agricultural research through the land-grant appropriations. If biological research should be influenced by medical viewpoints under these bills as it has by agricultural applications under the other Federal acts there will be no endowment for fundamental work. National safety rests on the continuation of basic research rather than on the application of what we already know.

The colleges, universities, and research institutions must have freedom in method and scope of research without rigid controls and insistence upon immediate practical results.

(2) *Make-up of the board.*—The scientists with whom I have talked favor a board made up of men of demonstrated capacity, appointed by the President, with authority to elect a director. Most of them think that the President should be guided by nominations from organizations of national standing. There may be some controversy in determining just which organizations should be recognized but the principle seems sound. I do not share the belief that men of ability and standing will not serve as readily in peacetime as in wartime, provided that the organization has a set-up to which each man can subscribe.

(3) *The award of fellowships.*—It is axiomatic that we cannot have continuous scientific development without the constant addition of new workers. We must look to the colleges and universities, and especially to the graduate schools, for new personnel. It is to be hoped that a plan can be developed for supplementing all other types of student aids so that no youth of promise need forego education and training because of lack of means. I do not share the idea that they must be regimented in case of an emergency. They will respond when the need arises if arrangemets permit. The provision for such arrangements are not a part of a bill to promote the progress of science.

I hope that fellowships will be available not only in all of the sciences and technologies but also in agriculture, engineering, mineral industries, and health and physical education.

In closing this statement I should like to add a strong plea for the recognition of social science. My primary interest has been in the natural sciences especially biology, which takes into account man's relation to things. Certainly none of us at this time, however, can fail to recognize the importance of man's relation to man. There are some who believe that the natural scientist who makes a discovery must be the one responsible for its effects. I should like to see the social sciences brought into larger opportunities and given support for the greater development of the human relations which the world needs.

If I dared I would add that it seems altogether unwise to attempt to include a patent policy in a Research or Science Foundation Act.

The patent problem is a particularly difficult one because the cases differ so greatly in the matters involved that they demand individual adjustment rather than a policy. It appears probable that the patent provisions now proposed might be interpreted to go beyond the scope of the foundation. If the agricultural experiment stations, which receive Federal aid are included, their present policies worked out through long experience might be jeopardized. Of course the work of these stations is financed only in part by Federal funds and the difficulties of determining responsibility are practically insurmountable.

The CHAIRMAN. Thank you very much, Dr. Kern.

We will adjourn until Monday morning.

(Whereupon the hearing adjourned at 1:40 p. m. until Monday, October 29, 1945, at 1 a. m.)

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